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Studies on the Biology  
of the Aquatic Hydrophilidae

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*Studies on the Biology of the Aquatic Hydrophilidae*

By E. AVERY RICHMOND

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BULLETIN

OF

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# BULLETIN

OF

## THE AMERICAN MUSEUM OF NATURAL HISTORY

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### VOLUME XLII, 1920

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#### Article I.—STUDIES ON THE BIOLOGY OF THE AQUATIC HYDROPHILIDÆ

BY E. AVERY RICHMOND

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## I.—INTRODUCTION

In this country very little attention has been devoted to the biology of the water beetles of the family Hydrophilidæ, and there exists a woe-ful lack of knowledge concerning the immature stages. A general survey of the aquatic members of the family was begun by the author in the spring of 1914 and has been continued until the present time. Primarily the New York State species, especially those occurring in the vicinity of Ithaca, have been dealt with but the collection of the United States National Museum (which consists mostly of European material) has also been examined. All the genera here discussed have been reared by the author. Some specimens of the genus *Hydrous* were furnished through the courtesy of Dr. Robert Matheson of Cornell University. Throughout this paper the classification as given by the European authors has been maintained as far as advisable, the grouping in use in this country not having been influenced by the recent work of foreign authors.

For help toward the completion of this paper, I am greatly indebted to the following men: Dr. J. G. Needham, who personally directed this work; Mr. F. E. Wintersteiner, who so willingly helped in the identification of the adults; Dr. Adam Böving of the United States National Museum, who gave valuable suggestions in regard to the larvæ, descriptions and drawings; and Dr. L. O. Howard, who kindly placed the specimens of the United States National Museum at my disposal.

A set of the material upon which this paper is based is deposited in The American Museum of Natural History.

## HISTORICAL

The Hydrophilidæ as a distinct group was first recognized by Latreille<sup>1</sup> when, in 1804, he applied the name Sphæridiota to this family. The earliest data found concerning the biology pertain to the genera *Hydrous* and *Hydrophilus*. This was presented respectively by Frisch in 1721 and Roesel in 1749. Until the middle of the nineteenth century very little was added; and it was not until Schiödte's Monograph in 1861 that any collected work of note appeared.

The little work that has been done in this country upon the natural history of this group of beetles consists only of scattered observations on the larger species. Life histories of American forms have been con-

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<sup>1</sup>Latreille, 1804, Hist. Nat. Crust. Ins., X, Ann. XII, p. 48.

tributed by Garman, Riley, and Matheson on *Hydrous triangularis*; by Wickham on *Tropisternus glaber*; by Wickham and Bowditch on *Hydrocharis obtusatus*; and by Böving on *Hydroscapha natans*.

In Europe there has been more activity. The work of Schiödte, 1861-1872, stands foremost and his results have been well supplemented by that of Balfour-Browne, Megusar, Miall, Planet, Duges, Reitter, Ganglbauer, and d'Orchymont. Schlick, Wesenberg-Lund, and Böving in Denmark have reared much important material, most of which has, through the efforts of Dr. Böving, been deposited in the National Museum at Washington. They have, however, published very little of their results.

The most valuable papers of today are those of Ganglbauer and d'Orchymont. The former's paper gives a lengthy survey of the family, based on the life histories as well as on adult structures. The latter's work presents new life histories in a number of genera, careful descriptions and figures, a discussion of the larval breathing apparatus, and a generic key to the known larvæ. Balfour-Browne has given the most complete treatise on any one species. He treats the entire life history of *Hydrobius fuscipes* from egg to adult, describing each stage and its biology in full and accompanies the whole with excellent figures.

It seems advisable to mention only the most important authors at this point. The others will be considered under the biology of the separate genera.



Table of known life histories of aquatic *Hydrophilidae*  
(American genera)

NAME	EGG	LARVA	PUPA	INVESTIGATOR	COUNTRY DATE
<i>Helophorus</i>					
1. <i>aquaticus</i> Linn.	*	*	*	Schiödte	Denmark, 1862
2. <i>granularis</i> Linn.	*	*	*	Schiödte	Denmark, 1862
3. <i>rufipes</i> Bosc.		*		Perris	France, 1876
4. <i>viridicollis</i> Steph.			Incomplete	Zambeu	France, 1894
5. <i>schmidtii</i> Villa			*	Zambeu	France, 1894
6. <i>micans</i> Fald.		*		Ganglbauer	Austria, 1904
7. <i>lacustris</i> Lec.	*	*		Author	United States, this paper
8. sp. ?	*	*		Author	United States, this paper
<i>Limnebius</i>					
1. <i>truncatellus</i> Thumbg.	*	*	Noted but not desc.	d'Orchymont	France, 1915
2. <i>discolor</i> Casey	*	*		Author (descr. in part)	United States, this paper
<i>Ochthebius</i>					
1. <i>punctatus</i> Steph.		*		Haliday	England, 1856
2. <i>subinteger</i> Muls.- Rey, subsp. <i>le-</i> <i>jolisi</i> Muls.-Rey		*		Mulsant-Rey Fauvel d'Orchymont	France, 1861 France, 1865 France, 1913
3. <i>quadricollis</i> Muls.		*		Ray	France, 1887
4. <i>impressus</i> Marsh.			Noted but not desc.	d'Orchymont	France, 1913
5. <i>steinbuehleri</i> Reitt		*		d'Orchymont	France, 1913
6. <i>tuberculatus</i> Lec.	*	*		Author	United States, this paper
7. sp. ?	*	*		Author	United States, this paper

Table of known life histories of aquatic *Hydrophilidæ*  
(American genera)

NAME	EGG	LARVA	PUPA	INVESTIGATOR	COUNTRY DATE
<i>Hydræna</i> 1. <i>pennsylvanica</i> Kiesw.	*	*		Author	United States, this paper
<i>Hydrosapha</i> 1. <i>natans</i> Lec.	*	*	*	Böving	United States, 1914
<i>Hydrochous</i> 1. <i>squamifer</i> Lec.	*	*		Author	United States, this paper
<i>Hydrophilus</i>  1. <i>caraboides</i> Linn.  2. <i>obtusatus</i> Say	 *  * * *	 *  * * *	 *  * * *	 Roesel Lyonnet Schiödte Bowditch Wickham Author	Germany, 1749 France, 1832 Denmark, 1862 Mass., 1884 Iowa, 1895 New York, this paper
<i>Tropisternus</i> 1. <i>lateralis</i> Fabr.  2. <i>glaber</i> Herbst	  *	 *  * *	 *  * *	Duges  Wickham  Author	Mexico, 1884 United States, (Iowa), 1893 United States, this paper
<i>Hydrous</i> 1. <i>piceus</i> Linn.  2. <i>aterrimus</i> Eschsch  3. <i>triangularis</i> Say	 *  * * *	 *  * * *	 *  * * *	Miger  Schiödte  { Garman Riley	France, 1809 Denmark, 1862 United States, 1881 United States, 1881



*Table of known life histories of aquatic Hydrophilidæ*  
(*American genera*)

NAME	EGG	LARVA	PUPA	INVESTIGATOR	COUNTRY DATE
<i>Berosus</i>					
1. <i>spinosus</i> Stev.	*	*	*	Schiödte	Denmark, 1862
2. <i>signaticollis</i> Charp.	*	*		{ Schiödte	Denmark, 1872
3. <i>striatus</i> Say	*	*		{ Brocher Author	France, 1911 United States, this paper
4. <i>peregrinus</i> Herbst	*	*		Author	United States, this paper
<i>Laccobius</i>					
1. sp. ?		*		d'Orchymont	France, 1913
2. <i>agilis</i> Randall	*	*	*	Author	United States, this paper
<i>Ancæna</i>					
1. <i>limbata</i> Fabr.		*		d'Orchymont	France, 1913
2. <i>infuscata</i> Motsch.	*	*		Author	United States, this paper
<i>Paracymus</i>					
1. <i>æneus</i> Germ.			Incomplete	Zambeu	France, 1894
2. <i>subcupreus</i> Say	*	*	*	Author	United States, this paper
<i>Hydrobius</i>					
1. <i>fuscipes</i> Linn.	*	*		Cussac	France, 1855
	*	*		Schiödte	Denmark, 1862
2. <i>globosus</i> Say	*	*	Incomplete	Balfour-Browne Author	England, 1910 United States, this paper
<i>Chætarthria</i>					
1. <i>atra</i> Le Conte	Undescribed.				

*Table of known life histories of aquatic Hydrophilidæ*  
(American genera)

NAME	EGG	LARVA	PUPA	INVESTIGATOR	COUNTRY DATE
<i>Helochaeres</i>					
1. <i>lividus</i> Forst.	*	*	Incomplete	{ Cussac Schiödte	France, 1852 Denmark, 1862
2. <i>maculicollis</i> Muls.	*	*	*	Author	United States, this paper
<i>Cymbiodyta</i>					
1. <i>fimbriata</i> Melsh.	*	*	*	Author	United States, this paper
2. <i>blanchardi</i> Horn	*	*	*	Author	United States, this paper
<i>Helocombus</i>					
1. <i>bifidus</i> Lec.	Undescribed.				
<i>Philydrus</i>					
1. <i>testaceus</i> Fabr.	*	*	*	Schiödte	Denmark, 1862
2. <i>perplexus</i> Lec.	*	*	*	Author	United States, this paper
3. <i>nebulosus</i> Say	*	*	*	Author	United States, this paper
4. <i>ochraceus</i> Melsh.	*	*		Author	United States, this paper
5. <i>cinctus</i> Say	*	*		Author	United States, this paper
6. <i>hamiltoni</i> Horn	*	*		Author	United States, this paper

#### METHODS OF COLLECTING

The majority of these beetles live at the water's edge and, if the soil, grass, or other vegetation is stirred rapidly or washed briskly with the water, the Hydrophilids will soon be released and come to the surface. They can then be easily gathered by the hand or, if small enough, by the forefinger. They do not become submerged immediately as do the



Dytiscidæ but swim about on the surface until they regain shore or find some plant to aid them in descending. An examination of the banks adjacent to the collecting grounds at the time of transformation will offer good collecting because often the larval skin, pupal skin, and adult may be procured in the pupal cell at one time. Some of the species are attracted by are lights during warm nights and, in fact, it is there that *Hydrous* is most frequently obtained.

#### METHODS OF REARING

The isolation, according to species, of adults, which readily lay eggs in captivity, proved the best method of acquainting oneself with the immature stages. Newly hatched larvæ are thus easily obtained. The most advisable temporary aquarium for such work seems to be a small stender dish. A small stone, half submerged in the water and draped with *Cladophora* gave excellent conditions for egg laying, especially for the smaller beetles which, as a rule, lay their eggs in moist places and not directly in the water.

For larvæ, larger containers produce better results. Moreover, they should be arranged as aquaria-terraria, for many of the adults and larvæ spend most of their time on shore. In preparing this, it is best to get some mud from the bottom or edge of a pool and, after placing it in the container to the depth of about an inch, slope it up gradually so that it forms a miniature bank. The bank end should be normally high enough so as to be a little dry on the surface. *Cladophora* and moneywort make the best plant materials because of their cleanness and lasting qualities. As a rule, the container should be filled so that the bank is covered and then placed in the sun. In a few days, the time depending on the conditions in the pool where the mud was obtained, numerous entomostracans destined to be food for the future larvæ will be present. The vegetation is then added.

The larvæ, when fully grown, seem restless and try to crawl out. If the time for transforming has arrived, they rapidly burrow down and form their pupal cells. Some, however, pupate on the surface of the terrarium, evidently not liking the conditions below. Slightly moist earth seems to be the most natural substance for the terrarium and an inch or so depth will suffice. If not too deep, they will often make their cell next to the glass container, where it is favorable for observation.

## II.—LIFE HISTORY AND BIOLOGY

## GENERAL SURVEY

Without doubt, the water-scavengers are the most abundant of our water beetles. In this respect they are approached only by the Dytiscidæ which are better adapted to aquatic life. The smaller members of this group are very numerous, and yet are often overlooked.

Their most common habitat is within the confines of some little pool which, as the seasons progress, becomes filled with algæ and other aquatic vegetation. Nevertheless, all the species may be taken in rapidly flowing streams but usually near the bank in débris, moss, etc., or in protected bays, where the water flows the slowest. One isolated record shows the capture of *Cymbiodyta fimbriata* beneath some falls in a bed of moss. The genera which are best adapted for living at some depth and under harsher conditions than the others are *Hydrous*, *Tropisternus* and *Berosus*.

The adult is chiefly herbivorous. It feeds mostly on the lower plant forms, such as algæ, but does not seem to be restricted to this diet. Decaying vegetation is its most popular food and it feeds readily on dead animal tissue (earthworms, larvæ, etc.).

It is an air breather, though much of its time is spent below the water. To obtain air<sup>1</sup> the beetle comes to the surface and extends its pubescent antennæ above water. They are then folded under the head and the air which has gathered on the antennæ is passed on to the hairs of the prothorax. Inspiration takes place by means of the pro-mesothoracic spiracles only. The air passes through the tracheæ and, as fast as used, is expelled through the other seven pairs of spiracles. It then spreads over the ventral side of the abdomen, where it is held as a film by the hydropscopic hairs. Thus the characteristic air film is formed. When a fresh supply is needed, the used air is passed along the prothorax to the antennæ again and the process repeated. Continual contraction and expansion of the body accompanies this breathing process.

Most of the Hydrophilidæ hibernate as imagines. It would be hard to tell where all of them spend their winter but a number of the species have been found in the bank a few feet from the water. They do not burrow down very deeply but remain near the surface, apparently in readiness to enter the water during any warm spell. An examination of the beetles which were taken from the bank or in early spring often

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<sup>1</sup>Brocher in his excellent paper (1913) carefully explains the respiration of *Hydrophilus*.



showed their bodies to be covered with many mites. Species of *Podophrya* and of *Epistylus* were also quite frequently observed upon them. Their lack of activity evidently allowed these harmless epizoans to gather on them; after a few days in the aquarium, they were lost.

The principal egg-laying months are May and August, although the egg-cases of some species may be found during the entire summer. The eggs, usually placed in "cocoons" (better called egg-cases) of silken structure, hatch out in about seven days. Many eggs are laid by a single individual, thus making up part of the enormous mortality which occurs among the young larvæ.

The silken material which protects the eggs is secreted by the female from glands located in the caudal end of the body. It is applied by the two spinnerets in a manner very much resembling the way a paint brush is used. A continuous flow of silk is laid down at each turn. According to Miger, there are in *Hydrous* three secretions, each of which has a different use. The first for loose spinning is used for covering the individual egg; the second for constructing the egg-case; and the third to form the mast at its tip. The function of this mast is a problem, although many suggest that it aerates the case. Several genera place their cases or single eggs below water, so that this supposition does not appear entirely plausible.

The larvæ, when first appearing, are whitish in color, except for the reddish pigment of the ocular areas, but soon the chitinized portions of the body darken. The first duty of the aquatic larvæ is evidently to get what is called an "air drink." They lift their heads above water and, with the aid of a pharyngeal pump, draw air into their alimentary canal. Air is also taken into the tracheæ through the stigmatic atrium which rests upon the surface film. By thus supplying their bodies with air the larvæ become buoyant. Otherwise they would be heavier than water and soon sink, dying because of lack of oxygen.

The larvæ are carnivorous and cannibalistic as well, the different genera varying in their greed. The young larvæ feed upon small organisms (entomostracans,<sup>1</sup> *Tubifex*, leeches, etc.) and increase the size of their prey as they themselves increase in size.

The full-grown larva feeds readily on pollywogs, annelids, fish, and, in fact, almost anything that it can overcome or that is fed to it. It lies in wait for its prey with its jaws extended widely and, as a rule, is half in the water and half out, the caudal end being out. When it begins

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<sup>1</sup>*Helophorus* was observed feeding on *Simocephalus*, *Cypris*, *Cypridopsis*, *Cyclops*, and *Canthocampus*.

eating, the larva lifts its head out of the water and manipulates its food by means of the mouth-parts. The labium and maxillæ are used as guides and to hold the prey while the mandibles macerate it. The legs play no part in the handling of the food. Predigestion occurs and the dissolved food is then drawn into the mouth by the suction of the pharynx.<sup>1</sup> There is neither lock to the mouth nor tubes in the mandibles such as are found in the dytiscid larva. This method of feeding refers only to the aquatic larvæ of the family and to *Helophorus*. I have not observed the feeding of the other, terrestrial forms. According to d'Orchymont, however, predigestion apparently does not take place in them.

There are usually two molts occurring during the larval period, which lasts one or two months. *Hydrobius*<sup>2</sup> evidently proves an exception to the rule, as its larvæ are found nearly full-grown in the early spring and even then do not transform immediately. The typically aquatic larva grows very rapidly and the first two instars take only about a fortnight. Most of its life is, therefore, spent in the third or last instar.

When ready to pupate, the larvæ leave the water and burrow in moist earth, often under stones or sticks, where they mold a cell slightly larger than the pupa to be formed. In the prescribed time (3-7 days) the pupal skin is ruptured and the adult emerges soon after but usually remains in the cell until fully colored.

#### EXPLANATION OF TERMS USED

In order that the terms that are used in the technical descriptions may be understood by the reader, a brief explanation of them is given here and illustrations of typical structures are shown in Plate I. No work has yet appeared in this country which deals with the difficult structures of a campodeiform larva such as we find in this family. Hopkins' paper on *Dendroctonus* has proved very useful, but the structures of that type of larva have not been compared with those of the hydrophilid type. I have, therefore, used, for the most part, the terms employed by European writers. D'Orchymont does not discuss the various terminologies, except in regard to the stigmatic atrium. However, his labeled figures of the mouth-parts and his numerous notes aid materially in giving one a clear understanding of his interpretation of

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<sup>1</sup>Method described by Balfour-Browne, 1910.

<sup>2</sup>Miall reports hibernation in larvæ of *H. fuscipes* and the author has observed it in *H. globosus*.

the various structures. Dr. Böving, who has studied the attachment of muscles in larvæ, has kindly offered valuable suggestions as to the homologies of the abdominal folds.

The fully developed and typical hydrophilid egg-case consists of the egg-case proper, containing the eggs; a cap covering the entrance to the latter and a projection continuous with the cap, which may be either a horny mast, tube, or filament. In giving the measurements of the case, the cap has always been considered as one end of the case.

The head of the larva may be inclined, horizontal, or elevated, with respect to the axis of the body, depending upon the shortening or lengthening of its upper or lower side. The epicranial suture, which may be present or absent, is formed by the union of the frontal sutures along the median line. The gula is the sclerite to which the submentum is attached. The epistoma is the sclerite just behind the clypeus and its lateral expansions attain the front margin of the head just lateral to the labro-clypeus. Schiödt called their angular projection the frontal angle. The upper surface of the mouth region on the under side of the labrum is the epipharynx; and, on the under surface, continuous with the mentum, is the hypopharynx. Ocular area is the term used for each of the eye spots behind the antennæ because ocellus is misleading and must be restricted to the adult. The antennal appendage is a finger-like lobe borne by the second segment of the antenna, and there may be two of these appendages. The *lacina mobilis mandibuli* is a flat unjointed lobe which the posterior piece of the mandible bears; it is toothed apically. The molar surface of the mandible is the grinding inner surface near its base. The parts of the labium and maxillæ may be seen in Plate I, figs. 1 and 5. Palpifer is restricted to the palpus-bearing segment of the maxilla, while palpiger is applied to that segment of the labium. "Articulating piece of maxilla" refers to the area between the cardo and the labium upon which the maxilla articulates.

A segment of the larva consists of a tergum, two pleura, and a sternum. The folds of the abdomen are very confusing and need further study. I have considered the hypothetical types of the abdominal tergum as possessing four transverse areas, namely, the præscutum, two scuta and a scutellum. The præscutal area is flat, while the other areas are represented by transverse folds. Between adjacent segments of the abdomen, there is a prominent region which is called the "intersegmental membrane." This may possibly be the postscutellum, but it has not been considered as such in this paper. The number of folds in this area is two at the most



The spiracular area, which bears the spiracle, is just lateral to the tergum.

The pleural region is composed of the hypopleurite and the epi-pleurite, the latter above the former. They are usually fairly distinct and bear lobes. The sternal region usually consists of the same number of folds as the tergal region but is much more complex. As in the latter, there are corresponding folds known as the præsternum, sterna (two folds) and sternellum.

The stigmatic atrium, or caudal breathing apparatus, offers opportunity for controversy as to the segments which compose it, but I have considered it as formed by the modified eighth and ninth segments. The procercus is the process of the eighth pleurite; the mesocercus, or true cercus, is always an appendage of the ninth segment; the acrocercus is an appendage of the lateral lobe of the ninth segment and arises from its ventral side; and the prostyle ("flotteurs" of Portier), which precedes the anus, is an appendage of the tenth segment. The motory stylus is a fleshy process of the pupa, resembling a seta. It may or may not bear a terminal seta and is usually annulate. The pterotheca is the pupal covering of the adult wing.

#### GENERAL CHARACTERS OF THE FAMILY (IMMATURE STAGES)

The eggs are whitish (brownish in *Hydroscapha*), oval in shape, and with a small projection at the anterior end. The eggs, varying in number from one to one hundred and forty odd, are usually enclosed in a silken case<sup>1</sup> but, in the more primitive forms (*Ochthebius*, *Limnebius*, and *Hydroscapha*), the eggs are deposited singly, without any covering or with one of loosely applied silk. *Cymbiodyta* and *Paracymus* lay their eggs in masses but cover them only sparsely with silk. The cases are either free floating (*Hydrous*, *Hydrophilus*); attached to water plants or debris at the surface of the water (*Tropisternus*, *Philydrus*, *Hydrobius*, *Laccobius*, *Ancæna*); below water (*Berosus*); embedded in mud, moss, etc. (*Hydrobius*, *Helophorus*); carried on the under side of the body (*Spercheus*, *Epimetopus*, *Helochares*, *Chætarthria* ?); or placed in dung or damp earth. The egg-masses of *Cymbiodyta* and *Paracymus* and the single eggs of the more primitive species are deposited under fallen leaves, vegetation or stones near the edge of the water.

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<sup>1</sup>Stein, 1847, who found silk glands in many genera, supposed that all eggs were covered with silk but the degree of covering varies greatly.

The larva is campodeiform; its head inclined (more primitive genera), elevated (more specialized genera), or nearly horizontal (*Helophorus*, *Hydrochous*); ocular areas in groups of five or six, distant or aggregated, reddish, round or oval, convex or flattened; antennæ three-segmented, rarely four-segmented (full-grown larva of *Hydrous triangularis*); epicranial suture present or absent; points of insertion of antennæ situated nearer or farther from the externo-frontal angles than those of the mandibles; labrum and clypeus well developed and distinct (more primitive genera) or reduced and fused (more specialized genera); mandibles with *lacinia mobilis* or sharply pointed and with inner teeth; maxilla palpiform or with stipes possessing a well-developed inner lobe; maxillary palpi three-segmented; labial palpi two-segmented; ligula present or absent; gula well developed and attaining the occipital opening or reduced and not attaining the occipital opening; labium and maxillæ inserted in a furrow on the under side of the head (more primitive genera) or not inserted in a furrow (more specialized genera); legs segmented and with claw-like tarsi, without tarsi (*Sphæridium*), or legs entirely absent (*Cercyon*).

Abdomen with nine well-developed segments and a reduced tenth or eight well-developed segments and reduced ninth and tenth. The body is usually slightly chitinized. The types of breathing overlap but there is a marked tendency in each genus towards one of three types: holopneustic, apneustic, or metapneustic. The spiracles (one pair of mesothoracic and eight pairs of abdominal) may be well developed before spiracles (*Helophorus*), annuliform spiracles (*Ochthebius*, *Limnebius*, *Hydræna*), apparently absent (*Hydroscapha*), or poorly developed before spiracles (the remaining genera). Cerci absent (*Hydroscapha*) or present as three-segmented or two-segmented appendages; reduced in the higher forms.

The pupa<sup>1</sup> is usually white in color except the eyes, which are reddish at first but change to nearly black before emergence. However, *Tropisternus lateralis* and *Hydrophilus obtusatus* are greenish. The anterior and posterior ends of the body are incurved and are not visible from the dorsal side. The integument is smooth, except that it is sparsely covered with styli. The supraorbital setæ are usually present but there is only one in *Hydrous triangularis* and none in *Tropisternus glaber*. The pronotal styli vary in number and size. There are only sixteen in

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<sup>1</sup>The pupa of the most primitive forms has not been described.

*Helophorus* and thirty-two in *Hydrophilus*. The number seems to be constant in the Hydrobiinæ as all specimens examined had twenty-four styli. Both the meso- and metathorax have a dorsal transverse row of two setæ. The wings are folded down over the ventral side of the body and the metathoracic pterothecæ may (terrestrial species) or may not (others) be visible from above. The first to seventh abdominal segments each possess, dorsally, a transverse row of four to six styli. The second to seventh abdominal pleurites each bear a stylus. The cerci are present and well developed.



GENERAL CHARACTERS, LIFE HISTORY, AND BIOLOGY  
OF THE FORMS STUDIED

1. **Helophorinæ**

Egg-case proper continuous with a distinctly hollow tube at the cap end. Many eggs enclosed. Larva with the head nearly horizontal, slightly elevated; ocular areas round, convex, and in groups of six, closely aggregated; antennæ with their points of insertion nearer the externo-frontal angles than those of the mandibles; antennal appendages of second segment two in number; epicranial suture absent; labrum and clypeus reduced; mandibles stout, sharply pointed, and with distinct inner teeth; labium and maxilla inserted at the anterior margin of the under side of the head; maxilla palpiiform; palpiger slightly dichotomous at the distal end; gula reduced and distant from the occipital opening. Abdomen with nine complete segments, each with tubercular areas, the tenth distinct but reduced; cerci three-segmented. Holopneustic type of breathing with well-developed before spiracles.

**HELOPHORUS** Fabricius

Often taken in company with the common *Ancæna* and *Paracymus*, these three genera are the most abundant in the Cayuga Lake basin. All representatives of this genus may inhabit the same pool but more frequently the different species seem to be segregated. It is difficult to distinguish the various species in the field but, as a rule, *H. lacustris* may be known by its usually larger size. In addition to it, *H. linearis*, *H. viridicollis* (*lineatus*), and *H. granularis*, named in the order of their abundance, are found here. Very little work has been done in this country on the species. They are very close to each other in structure. Distribution is limited, the representatives occurring only in the pale-arctic, nearctic, and Central American regions. European authors have worked extensively on the life histories of *Helophorus* and they are listed in the table (page 5), but in America nothing has been done. However, *H. granularis*, which Schiödte described, is holarctic.

Egg-cases were taken out-doors in May and June. The cases were formed in moss or alga near the bank with only the tubular filament exposed, the egg-case proper being hidden completely. From six to ten eggs were found in each of the cases. During the latter part of May several larvæ were taken, in company with *Ancæna* larvæ, from the under side of a stick at the water's edge. While the larvæ have been observed eating entomostracans and various other animal tissue, it is worth recalling Perris' note that *H. rugosus* was observed in the stalk of *Brassica* preying on a *Psylliodes* larva.

**Helophorus lacustris** LeConte

## Plate II

Two egg-cases were noted deeply embedded in moss at the water-line and only the tubes were visible. The cases proper were covered with sand and mud but the tubular filaments were clean and white. Thirteen larvæ were obtained from these cases and they made their escape through the tubes. A preserved case shows three of the larvæ in the tube at one time, one behind another. Several other cases were obtained in the laboratory, where they were laid in some alga which had been pulled out of the water and placed on the side of the aquarium. A part of the alga was left hanging in the water and this kept the remainder moist.

EGG-CASE! somewhat flask-shaped. Egg-case proper nearly round, measuring 1.69 mm. in width; tube, 0.94 mm. wide distally. The whole 4.84 mm. long; the opening is obliquely across the end of the tube and extends 1.076 mm. down the side.

NEWLY HATCHED LARVA.—Length, 2.55 mm.; width, 0.403 mm. Whitish except chitinized portions, which are brownish with head yellowish in part; integument more chitinous than in other larvæ and with only a few scattered setæ.

Head quadrangular, only slightly elevated, dorsal side one-half the ventral in length, posterior margin with a prominent semicircular emargination; fronto-clypeal suture weakly indicated, more prominent towards the middle; frontal sutures converging gradually and joined by a short transverse suture contiguous with the posterior margin of the head; epicranial suture absent; gula polygonal; gular sutures confluent; cervical sclerites evidently not present.

Labro-clypeus triangular (subconical). Lateral expansion of the epistoma prominent, similar, rounded, about even with the anterior margin of the labro-clypeus and each bearing seven, stout, recurved spines; epipharynx spinous.

Ocular areas in groups of six and closely aggregated; roundish; arranged in two rows of three each and all equidistant from each other. The hind row set slightly nearer the median line than the front row.

Antennæ short, slightly exceeding the mandibles; first segment about as long as the second, slightly constricted near the base; second segment widened towards the tip, obliquely truncate, possessing distally in the membrane a pair of two-segmented, lobiform antennal appendages on the outer side in addition to a strong seta and two strong distal setæ on the inner side; terminal segment cylindrical, much narrower than the other segments and provided with several apical setæ.

Mandibles symmetrical, prominent, sharply pointed at their tips and with the inner surface of the anterior piece serrate; two<sup>2</sup> inner teeth on each mandible about equal in size; a strong medio-lateral spine present; molar areas smooth.

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<sup>1</sup>The egg-case of *H. aquaticus* figured by Schiödte differs greatly from our generic type and I doubt his accuracy.

<sup>2</sup>*H. granularis* has only a single inner tooth.

Maxillæ with palpifer not joint-like; stipes fairly large, swollen, not noticeably narrowed towards the apex, only a little longer than the palpifer, its inner surface provided with a row of five stout setæ, another just inside the most distal one and two slender setæ near the externo-distal angle; palpifer fairly large, a little longer than wide, bearing an inner stout lateral seta; a slender seta in the externo-distal angle and a slender cylindrical appendage in the interno-distal angle, exceeding the first segment of the palpus, with sense-cones and a seta at its tip as well as those nears its base; palpus cylindrical, tapering slightly with sense-cones at the distal end; the second segment slightly longer than the other two.

Labium not exceeding the mandibles, but prominent and just attaining the distal end of the palpifer; submentum small; mentum not exceeding the tooth of the labroclypeus, cylindrical, a little longer than wide, and slightly swollen distally; palpiger equal to the mentum in length, its sides diverging and forked distally; the palpi, borne by the two forks, cylindrical and tapering; the second segment about twice as long as the first and with sense-cones at the tip; ligula absent.

Prothorax with angles obtuse; well indicated, only a little wider than the head, sides parallel; anterior and posterior of pronotum non-chitinated; sagittal line present; prosternum chitinated in front and lateral to the coxæ. Mesothorax and metathorax equal to each other in length but shorter than the prothorax and becoming very slightly narrower than the latter caudally. The nota are entirely chitinated and each bears a transverse row of four prominent setæ. The sagittal line, which continues throughout the eighth abdominal segment, prominent. A pair of bifore spiracles on the mesothorax.

Legs fairly long, slightly longer than the thorax is wide; coxæ transverse, grooved laterally to receive the femora; femora a little longer than the tibæ; tarsi claw-like, about as long as the latter and with no inner setæ; the anterior coxæ are closer together than the four posterior coxæ, which are about the same distance apart.

Abdomen with nine distinct segments, very slightly narrowed caudally. Anal segment projecting, short and cylindrical; the first seven abdominal tergites similar and resemble the meso- and metanota in the arrangement of the setæ and their chitination. Dorsally a row of four setæ on each segment, each seta emerging from a broad, rough tubercled area, which is chitinated and separated from the others by a longitudinal furrow or suture. Laterally two similar chitinated tubercled areas, the posterior one larger and with a seta (both probably correspond with the epipleurite); hypopleurite similar, one-lobed and with a seta. The sagittal suture very distinct as well as the longitudinal furrows. Ninth segment narrower than the eighth and nearly twice as long with a prominent lateral seta on each side, corresponding to the seta of the lateral tubercled areas just mentioned; only the tergite is chitinated. Arising from the posterior margin are two divergent, three-segmented, cylindrical, tapering cerci. The first segment bears a ventral and dorsal seta, the second a terminal seta just below the origin of the third segment, which has a terminal seta as long as the three segments together. The three segments bear the relation of 16, 12, and 18 to each other in length. Each spiracle<sup>1</sup> is just below and in front of the outer dorsal tubercled area. First eight sternites with a transverse row of four tubercles, each bearing a seta which has a small, chitinous plate at its base, and a small seta each side of the median line near the anterior margin. Three transverse folds are present

<sup>1</sup>Compared with the other Hydrophilidæ, which possess them, the bifore spiracles are well developed.



ventrally, the first ovo-oblong, the second somewhat rectangular, and the third tripartite with the middle bilobed, each lobe with a seta, the lateral parts triangular and with a seta.

### **Helophorus aquaticus** Linnæus

The identical life history material of this European species used by Schiödte in his work on this genus is located in the collection of the United States National Museum but is in poor condition. An examination of the full-grown larva shows that the sclerites in front of the procoxæ are not so prominent as in the younger larvæ. The abdomen is only slightly more strongly chitinized than in the first stage larva and the intersegmental membranes are present but not prominent. The setæ are lost in the specimen examined but this may be due to its poor condition. The following pupal description may well be incorporated.

**PUPA.**—Length, 8.5 mm.; width, 2.00 mm. at its thorax. Whitish (specimen browned with age). Head smooth and bears two supraorbital styli on each side. Pronotum smooth, its anterior margin somewhat trilobed and its posterior margin with a large median lobe. The styli<sup>1</sup> are arranged as follows: ten on the lateral and anterior margins, two of which are on the middle lobe; six on the posterior margin, counting the two corner ones; no styli are to be seen in the central area of the pronotum but may have been destroyed. (Schiödte's figure gives none.) Mesonotum and metanotum with a transverse row of two setæ. Inner spur of metatibia fairly prominent. All tarsi probably ending in a spine but not very clear and tibiæ not noticeably spinous on the outer side. Metathoracic pterothecæ conspicuous from above. First to seventh abdominal tergites with a transverse row of four styli. Second to seventh pleurites each with a stylus, all arising from small conical tubercles; eighth tergite somewhat semicircular, the rounded posterior border bearing two styli; one lateral stylus noted on each side below the eighth tergite; ninth segment with a pair of short, conical, fleshy cerci about the same length as the ninth tergite. They diverge only slightly and their sharp tips point inwardly.

### **2. Limnebiinæ**

Eggs laid singly with a slight covering of loosely applied silk. Larva with head inclined; antennæ with points of insertion situated nearer the externo-frontal angles than those of the mandibles; epicranial suture present; ocular areas round, coarctate and in groups of five, not closely aggregated; labrum and clypeus both well developed; mandibles each with a *lacinia mobilis*; maxilla primitive with an inner lobe; labium with short palpi; fleshy ligula present; labium and maxillæ inserted in a furrow on the under side of the head; gula well developed and attaining the occipital opening. Nine complete abdominal segments each with a ventral and dorsal plate, and a distinct but reduced tenth or anal segment. Cerci two-segmented. Holopneustic type with annuliform spiracles.

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<sup>1</sup>The basal part of the stylus is short and the terminal seta long.

**LIMNEBIUS** Leach

D'Orchymont gave the first description of the larva of *Limnebius*. The eggs and pupa have not been described.

**Limnebius discolor** Casey

Three specimens were taken the latter part of June near the bank of an alga-filled pool. The species is rare and has not been previously reported from Cayuga Lake basin. It is difficult to recognize in the field on account of its small size, but closer examination shows clearly its resemblance to the Hydrobiinæ type, with which it was formerly classed.

The eggs were laid on July 1 by captured specimens and one egg hatched on July 8. As this was the only larva obtained, it is considered inadvisable to give a description of it. However, the larva very closely resembles *L. truncatellus*, which d'Orchymont carefully described.

**3. Hydræninæ**

Eggs laid singly. In *Ochthebius* with or without a slight covering of loosely applied silk but in *Hydræna* covered with a blanket of closely spun silk.

Larva as with Limnebiinæ.

**OCHTHEBIUS** Leach

*Ochthebius* offers many interesting structures. *O. tuberculatus* is particularly unique and cannot be mistaken for any of the other species. Besides *O. tuberculatus*, *O. holmbergi* and several other undetermined members occur in the Cayuga Lake basin.

All of them are, in general, quite rare. However, when once located, many are usually collected in a very small area and one collecting ground kept me well supplied from late April until winter set in. The soil in this spot was especially sandy. Upon washing the sand with water and pulling up and washing the roots of the vegetation which grew there, many specimens were soon observed floating on the surface of the water or clinging to floating debris.

Haliday, 1855-6, was the first to figure a larva of this genus, namely, *O. punctatus*. The latest and best study is that of d'Orchymont. He worked out in detail the larva of *O. lejoli*, already described by Mulsant and Rey, 1861, and worked over by Fauvel, 1865. D'Orchymont also dealt with *steinbuhleri* and *impressus*. Rey, 1887, added *O. quadricollis* to the list of known larvæ.

Single eggs were deposited on the stones or algæ in an aquarium, out of water but in moist places. They were either entirely naked or, at times, covered rather uniformly with loosely applied silk. The silk was more compact, however, than in the scattered silk of the *Cymbiodyta* egg-masses but not as closely applied as in the complete egg-cases. The eggs were most frequent during May but some were laid the first part of July. From seven to ten days were required for incubation.

The larvæ are very different from those of the Hydrobiinæ and even from those of the Helophorinæ but are closely allied to the Limnebiinæ. On land, they move very rapidly and almost seem to run. They are very clumsy in water and doubtless spend their life on land but in moist situations. According to d'Orchymont, p. 190, the life of the larva probably lasts only two or three months. Adults of *O. impressus*, which he captured the first of August in order to restock his aquaria, were not fully colored, thereby indicating their recent emergence.

***Ochthebius tuberculatus* LeConte (*foveicollis* LeConte)**

Plate III

At times the collecting of this species proved so easy that they could be picked up almost indefinitely, the collector stopping only to wash them out. In the middle of September 1916 many were found in gravelly places which were practically devoid of vegetation. One can easily recognize them in the water because of their somewhat heart-shaped abdomen, which often sinks lower than the rest of the body.

EGG.—Length, 0.538 mm.; width, 0.215 mm. Naked or covered with loosely applied silk which is placed regularly so that the whole is uniform in shape.

NEWLY HATCHED LARVA.—Length, 1.345 mm.; width, 0.242 mm. Whitish, except the chitinized portions which soon become brown. Integument with many inconspicuous setulæ as well as regularly arranged setæ, which are fairly long, rigid, and brownish.

Head well rounded, globular; fronto-clypeal suture fairly well indicated; frontal sutures converging, uniting behind the middle of the head to form the epicranial suture, the whole presenting a Y-shaped appearance; frons somewhat triangular.

Gula fairly small, constricted laterally, the anterior and posterior angles produced into arms; cervical sclerites, if present, not noticeable. Epistoma apparently marked off from the frons by an irregular group of minute tubercles.

Clypeus fairly distinct, transverse, slightly arched, wider than the labrum and with a transverse row of six setæ, the median two widely separated but the others equidistant, near the anterior margin.

Labrum somewhat semicircular with four lateral setæ on each side, the anterior one bifurcate, short, and blunt; a stout seta in front of the latter; two, small, adjacent tubercles just inside the anterior margin and two others in a horizontal row



through middle but widely separated; two setæ just posterior and outside the former tubercles and two others posterior but inside the latter tubercles, both in a horizontal row. The lateral expansions of the epistoma not prominent. Epipharynx apparently not spinous.

Ocular areas round, five on each side, not aggregated; the first and second not seen from above, fairly close together and placed one back of the other just behind the insertion of the mandible at the side; the third and fourth about the same distance apart as the first two and located just posterior to the insertion of the antenna, the fourth more dorsal and posterior; the fifth widely separated from the fourth, more lateral and posterior.

Antennæ three-segmented,<sup>1</sup> fairly long, exceeding the mandibles; first segment more than twice as wide as long and less than one-third the second segment in length; latter about the same width, slightly constricted in the middle and with an outer swelling just proximal to the middle, bearing a small, blunt spine; distal end with four long setæ; third segment slightly constricted and distally with several prominent setæ.

Mandibles approximately symmetrical with broad bases, their tips with several finger-like processes, the arrangement on two mandibles differing somewhat; *lacinia mobilis* present, pectinate distally; molar area with numerous spinules and two inner teeth in front of it.

Maxillæ with palpifer joint-like and seeming to form the first segment of the palpus; a large internal lobe present, which clasps the stipes on the ventral side and shows a tendency to be divided distally into two lobes; the outer lobe tapers to a sharp point while the inner lobe is shorter, blunter, and fringed with a row of stout setæ distally as well as with several slender setæ nearer its base; cardo noticeable and as broad as the stipes at its union; stipes wider and longer than the palpifer and with two lateral setæ; palpifer about as wide as long; palpus tapering; second segment slender and only slightly longer than the first; terminal segment very small and somewhat flask-shaped.

Labium with palpi barely exceeding the labrum, short; submentum, reduced, transverse, indistinct; mentum broad but longer than wide, slightly constricted; palpiger transverse, slightly forked; palpus short, two-segmented, articulating membranes well developed; second segment narrower, shorter than the first, its margin flared distally and with apical setæ and papillæ; ligula present, barely exceeding the first segment of the palpus, rounded and furnished with papillæ (very similar to *Limnebius*).

Prothorax with sides and angles rounded, of the same width as the head. Proscutum well developed and entirely chitinized, sagittal line present; anterior and posterior margins with a transverse row of setæ; a median transverse row of setæ and several lateral setæ.

Mesothorax a little shorter than the latter, slightly narrowed in front. Mesoscutum well developed and entirely chitinized, less conspicuously in front; sagittal line present; a transverse row of setæ just in front of the middle and at the posterior margin; several lateral setæ. Metathorax the same. Sterna not noticeably chitinized.

Legs fairly long, about as long as the thorax is wide; coxæ transverse with a dorsal groove; femora about the same length as the tibiæ but a little stouter; tarsi slightly more than one-third the latter, claw-like and with no inner setæ.

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<sup>1</sup>Articulating membrane at base very prominent but non-chitinized.

Abdomen with ten distinct segments and narrowed caudally. The first eight tergites similar and each covered by a dorsal plate, the posterior angles and margin of which are rounded; a transverse row of setæ at the posterior margin and a fairly prominent seta at each side. Eight pairs of small round spiracles present and each situated in the spiracular area just inside and anterior of the lateral setæ. Pleural groove distinct. Each segment with a ventral plate less chitinized towards the anterior and with setæ arranged as on the dorsal plate. Ninth segment similar to the preceding ones, except that it is slightly longer and the irregular row of setæ are absent at the posterior margin, inside the insertion of the cerci. A pair of two-segmented, divergent cerci arise from the posterior margin of the ninth tergite, their points of insertion almost contiguous. First segment of cercus, longer than the anal or tenth segment, chitinized, constricted slightly in the middle and with several long distal setæ besides other shorter ones; second segment slender but not tapering; less than one-half the first segment in length and bearing a single, long, terminal seta.

Anal segment cylindrical, longer than wide, banded with chitin, the tip membranous, a row of short setæ around the caudal border of the band and a terminal pair of stout, recurved hooks directed downward.

#### HYDRÆNA Kugel

Only one species, *H. pennsylvanica*, is found in the vicinity of Cayuga Lake. One cannot fail to recognize the members of this genus because of their long, slender maxillary palpi and almost invariably hexagonal pronotum.

#### *Hydræna pennsylvanica* Kieswetter

##### Plate IV

The life history of this minute water scavenger has never been described. The small, elongate beetles are often overlooked unless one collects especially for them. They are found either in flowing or standing water and occur most frequently where the shore is muddy or gravelly. Specimens were collected throughout the spring and summer at the same special collecting grounds but they proved to be most numerous in April and May. Once located, the same spot will yield specimens for the rest of the season. The stock pool for 1915 was one of the railroad pools, east of the tracks of the Lehigh Valley Railroad, Auburn Division, and south of Fall Creek, where on April 14 over forty were taken by washing out the mud at the shore-line. During late August many of the beetles were observed crawling over stones and pebbles where the water lapped the shore of Cayuga Lake near the mouth of Taughannoek Creek. Their most common associates are *Paracymus subcupreus*, *Ochthebius tuberculatus*, *Hydrochous squamifer*, and *Cercyon ocellatus*.

As with *Ochthebius*, only one egg is deposited at a time. Eggs were laid in an aquarium during the middle and latter part of April.<sup>1</sup> They were placed on a leaf which rested on a stone, some in the water and some out but always in a damp situation. Each egg was kept in position by a blanket-like covering of closely applied silk which exceeded the egg on all sides and showed its form. The eggs hatch in six to eight days, emerging through a narrow, longitudinal slit in the upper side of the egg-case. The larvæ are very rapid walkers and closely resemble those of *Ochthebius*, almost seeming to glide over the surface of the stones when stimulated. They are clearly non-aquatic in their movements, becoming quite helpless when below the surface film.

EGG.—Length, 0.591 mm.; width, 0.242 mm. The flare-like margin exceeds the egg itself about 0.09415 mm. all around and is entire, being only slightly irregular.

NEWLY HATCHED LARVA.—Length, 1.29 mm.; width, 0.242 mm. Whitish except chitinated regions which soon become brown; integument with many inconspicuous setulæ as well as regularly arranged setæ which are fairly long, stiff and brownish.

Head strongly rounded, globular; fronto-clypeal suture weakly indicated, except at the sides; frontal sutures, converging, unite behind the middle of the head to form the epicranial suture, the whole presenting a Y-shaped appearance; gula small, constricted laterally, and its posterior angles extend to form long, lateral arms; cervical sclerites, if present, not noticeable.

Clypeus fairly distinct, transverse, slightly arched, wider than the labrum and with a transverse row of six equidistant setæ on the posterior half.

Labrum somewhat semicircular with four setæ on each side, the anterior one prominently branched (almost pectinate) while the third pair are strongly bent inward and tapering; anterior margin slightly emarginate with a short, finger-like appendage on each side, with a seta just behind but a little lateral; four other setæ on the upper side of the labrum; two near the middle and two on the posterior half but more widely separated. The lateral expansions of the epistoma are not prominent.

Epipharynx apparently not spinous.

Ocular areas round, five on each side, not aggregated; the first and second close together and placed one above the other just behind the gena<sup>2</sup> and below the base of the antenna; the third and fourth closely approximated, widely separated from the latter, and more dorsal; the fifth near the lateral margin of the head and distant from the fifth.

Antennæ fairly long, barely exceeding the mandibles; first segment about as wide as long and two-fifths the second segment in length; latter more slender with two swellings on the inner side, one at the middle, bearing a long seta and one near the distal end bearing a finger-like appendage besides a long seta; two seta just below the externo-frontal angle; third segment slender, longer than the finger-like appendage and more than one-half as long as the second with a seta arising from an inner tubercle near the middle and several terminal setæ mounted on tubercles.

<sup>1</sup>Many adults were taken *in copulo* out of doors at this season.

<sup>2</sup>The sclerite called the gena may open some question but it evidently corresponds in position to it.



Mandibles approximately symmetrical with broad bases, their tips with several finger-like processes; *lacinia mobilis* broad and toothed distally; two small inner teeth; molar area oval with its surface covered with numerous spinules and four small teeth in front of them.

Maxillæ with palpifer joint-like and seeming to form the first segment of the palpus; a large terminal lobe present, which clasps the stipes on the ventral side and is divided distally into two lobes fringed with setæ; the inner lobe with a row of setæ on its inner margin; stipes slightly wider and longer than the palpifer, which bears four inner setæ; palpus tapering and with the second segment slender and longer than the first; terminal segment very small and somewhat flask-shaped.

Labium with palpi barely exceeding the labrum, short; submentum reduced, transverse; mentum broad, cordiform; palpiger transverse, indistinct; palpus short, covering, distally provided with setæ and expanded with a flare-like margin; articulating membranes well developed; ligula slightly exceeding the first segment of the palpus, bowl-shaped and with large rounded papillæ at its tip.

Prothorax with sides and angles rounded, of the same width as the head. Proscutum well developed and entirely chitinized; sagittal line present; anterior and posterior margins with a transverse row of setæ; a median transverse row of setæ and a prominent lateral seta on each side near the middle. Mesothorax slightly narrower but the same length as the prothorax. Mesoscutum well developed and entirely chitinized; sagittal line present; the posterior margin with a transverse row of setæ, a transverse row on its anterior half and a medio-lateral seta on each side. The metathorax the same except that it is a little narrower. Sterna not noticeably chitinized.

Legs long, about one-half longer than the thorax is wide; coxæ transverse with a slight dorsal groove; femora a little shorter than the tibiæ; tarsi claw-like, more than one-fourth the latter in length, with no inner setæ but each with two inconspicuous outer ones.

Abdomen with ten distinct segments and narrowed caudally. The first eight tergites similar and each covered by a dorsal plate,<sup>1</sup> the anterior margin of which is straight while the posterior is rounded; a transverse row of six setæ at each posterior margin and a prominent lateral seta on each side arising from a small tubercle. Spiracles situated just inside and anterior of the lateral seta. Pleural groove distinct. Each segment with a ventral plate<sup>1</sup> less chitinized anteriorly and possessing a transverse row of six setæ near the posterior margin besides several others just anterior. Ninth segment similar to the preceding ones except that it is slightly longer, four inner dorsal setæ are lost, both lateral setæ are more posterior, and the median pair of ventral setæ at the posterior margin are set a little more anterior. A pair of two-segmented, divergent cerci arise from the posterior margin of the tergite, their points of insertion distant from each other. First segment of cercus tapering, longer than the anal or tenth segment, chitinized, and bearing two dorsal setæ near its base, three setæ about one-third the length of the segment from the distal end,<sup>2</sup> and a terminal ventral one. Second segment small, slender, cylindrical, only slightly chitinized, its tip flattened, membranous and bearing a terminal seta.

<sup>1</sup>The dorsal plate represents the scutum fused with the epimerites while the ventral plate represents the sternites fused with the episternites (d'Orchymont).

<sup>2</sup>The first segment appears to be subdivided but closer examination disproves it.

Anal segment cylindrical, longer than wide, and banded with chitin, the tip membranous, a transverse row of setæ anterior of the caudal border of the band and a terminal pair of stout, recurved hooks directed downward.

#### 4. *Hydroscaphinæ*

Eggs laid singly without a covering of silk.

Larva with inclined head; antennæ with points of insertion situated nearer the externo-frontal angles than those of the mandibles; epicranial sutures present; ocular areas round, convex and in groups of five more closely aggregated than with the other primitive larvæ; labrum well developed but clypeus<sup>1</sup> not present; mandibles small each with a *lacinia mobilis* and concealed from above by the labrum; maxilla primitive with an inner lobe; labium with short palpi; labium and maxillæ inserted in a furrow on the under side of the head; gula well developed and attaining the occipital opening. Nine complete abdominal segments, and a distinct but reduced tenth segment, the chitinized portion of all ten forming a continuous ring. Tracheal gills present on several segments. Spiracles reduced so that the openings cannot be seen. Cerci absent.

#### 5. *Hydrochoinæ*

Egg-case flat with a single egg enclosed. Larva with head inclined, antennæ with their points of insertion situated nearer the externo-frontal angles than those of the mandibles are; epicranial suture absent; ocular areas oval and in groups of six, closely aggregated; labro-clypeus very much reduced, the epistoma apparently at the anterior margin of the head; mandibles prominent, each with a slender distal piece terminating in a stout seta; and with a *lacinia mobilis*; maxilla palpiform, the inner side of the stipes with a small swelling; palpifer without a rudimentary lobe; labium with short palpi and ligula absent; labium and maxillæ inserted in a furrow on the under side of the head; gula small but attains the occipital opening; eight complete abdominal segments, and each with a dorsal and ventral plate. Ninth and tenth segments reduced. Type of breathing pseudo-metapneustic and the before spiracles are poorly developed.

#### *Hydrochous* Leach

As with the genus *Helophorus*, we find most of the species very closely related. However, the rare *Hydrochous scabratus*, with its prominently tubercled elytra, is a well-marked species. The most common species is *H. squamifer* but two closely allied and undetermined species (possibly undescribed) are almost as abundant. A few specimens of *H. excavatus* ? have also been recorded. The only genus with which the collector might confuse the adult is *Helophorus* but the former is easily differentiated in the water by the angular form and blackish color, which has a decided tendency to be iridescent. The seven-segmented antennæ and discal foveæ of *Hydrochous* clearly separate it from *Helophorus* with its nine-segmented antennæ and discal sulci.

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<sup>1</sup>The clypeus may have fused with the labrum.

In gathering the species, one finds them most frequently in company with *Ochthebius*, *Hydræna*, *Helophorus*, *Ancæna* and *Paracymus* but a great deal harder to locate, with the possible exception of the two first named. They seem to cling more tightly to the vegetation at the shoreline with their rather powerful claws. Standing water with gravelly bottoms and little vegetation or muddy pools seem to be their most common habitat. About fifty were taken the latter part of August 1916 in a lagoon west of the Cornell Biological Field Station. The waters at that time of the year are filled with *Ceratophyllum* (hornwort), *Spirodela* (duckweed), and *Elodea*, while cat-tails abound, taking root in the muddy bottom. *Hydrochous* was procured at the water's edge by washing the mud away from the roots of the cat-tails. They came to the surface immediately and, although very slow in action, they would quickly become submerged by grasping the vegetation with their claws unless washed out in deeper water. When their station, which seems to change each year, is once located they may be captured in large numbers but, otherwise, only scattered specimens are usually taken. - A single specimen of *H. scabratus* was procured in Dwyer's Pond by sweeping the submerged *Elodea*. When the imagos were placed in the aquarium they immediately sought the under sides of some stones, below the water, but when it was placed in the sun they soon came up, seeking the sunny side. A few days later they were observed eating holes in decaying leaves of moneywort and *Marsilea*, leaving only the tough veins.

The life history has not been described and it has proven to be of particular value in explaining the phylogeny of the family. Although the larva has a well-developed stigmatic atrium, yet its head and mouth-parts are quite primitive.

The laying season seems to be confined to the beginning of summer weather, about the latter part of May and the first of June. From the fifty imagos taken the latter part of August, not a single egg-case was obtained. A number of the beetles were taken *in copulo* on May 10 but no cases appeared until about May 23. A single egg was deposited at a time and placed between two layers of closely applied silk. The cases were fastened down to the algæ or rocks in the aquarium, either above or below water, and held firmly by the flap and stanchions. One case of *Hydrochous* sp.? was particularly well supplied with little stanchions. The egg-case of this genus is apparently one step forward from the egg-case of *Hydræna* in specialization.

The larvæ appeared through a rupture in the silk in about seven to eight days. They were quite at home in the water and the manner in



which the lobes and cerci, around the terminal spiracles, spread out over the surface of the water showed clearly its advanced development. They are much less active out of water than the Hydræninæ but nevertheless move rapid.

### **Hydrochous squamifer** LeConte

#### Plate V

EGG-CASE.—Length of egg, 0.5 mm.; width, 0.2 mm. The case is irregular in outline and varies in size but the egg is always placed towards one end of the case, the two layers of silk meeting to form a flap at the other end.

NEWLY HATCHED LARVA.—Length, 1.8–1.9 mm.; width at the thorax, 0.21–0.24 mm. Whitish except chitinized regions which soon darken; integument with many inconspicuous setulæ. Body somewhat cylindrical.

Head strongly rounded, shorter than wide, nearly horizontal; fronto-clypeal suture not visible; frontal sutures converging as far back as the middle of the head but then slightly diverging and not uniting to form the epicranial suture, the frons therefore concave at the sides; gula small, its posterior angles extended to form long lateral arms; cervical sclerites, if present, not noticeable.

Labro-clypeus very much reduced, the epistoma apparently at the anterior margin of the head, nearly straight in front, no toothed lobe present but with a transverse row of eight setæ at the anterior margin arranged in two groups of four equidistant from the median line; area immediately behind the latter bearing numerous setæ mounted on minute tubercles. Lateral expansions of the epistoma not prominent, rounded, and similar. Epipharynx with setæ on small tubercles; ocular areas in groups of six, oval, closely aggregated, arranged somewhat in a circle (the third and fourth slightly distant) with their longitudinal axes emanating from the center.

Antennæ fairly short, reaching only to the middle of the palpifer; first segment stout, slightly concave on the inside and slightly convex on the outside, about one-third longer than wide; second segment less than one-third the latter in length, narrower, a little longer than wide and bearing distally a finger-like antennal appendage in addition to the third segment; the latter not quite as long as the second segment and about as long as the appendage but a little wider and bearing terminal sense-cones. The intersegmental membranes separating the segments are well developed and allow the last two segments to be telescoped.

Mandibles symmetrical, the anterior pieces fairly slender, only slightly tapering, the tips membranous and each bearing a short recurved seta; *lacinia mobilis* slender and bifid at the tip; a single, sharply pointed inner tooth just in front of the molar area; latter setiferous.

Maxillæ with palpifer joint-like, stipes large, sides parallel, the inside with a prominent swelling surmounted by a group of setæ; palpifer shorter but equal in width, about as long as wide, swollen, three prominent inner setæ in addition to many small setæ mounted on minute tubercles, which cover the inside of the stipes as well; palpus tapering slightly, the second segment longer than the first but shorter than the thimble-like terminal segment which possesses apical sense-cones.

Labium barely exceeding the stipes of the maxilla, union of submentum and mentum not clear but submentum probably small while mentum is longer and cordiform; palpiger about as long as wide, cylindrical; palpus short; the first segment about one-half the second, which has small distal setæ that are mounted on minute tubercles. Ligula absent.

Prothorax with sides rounded, of the same width as the head; entirely chitinized; sagittal line present throughout the thorax. Meso- and metathorax similar, of the same width but a little shorter than the prothorax.

Legs not quite as long as the thorax is wide and robust; coxæ oval, transverse and with a dorsal groove; femora, tibiæ, and tarsi all about the same length; tarsi well developed, basal part long, claw-like and bearing two inner setæ.

Abdomen with eight distinct segments, all of the same width, ninth and tenth rudimentary. The first seven tergites similar and intersegmental membrane not well defined. Each segment covered with a dorsal plate, the anterior margin of which is straight while the posterior is rounded; no prominent setæ present but a lateral inconspicuous seta. Bifore spiracles mounted on small tubercles, just inside and anterior to the lateral seta. Pleural groove distinct. Each segment apparently with a ventral plate corresponding in structure with the dorsal plate; eighth segment with sides only slightly rounded out, of the same width as the preceding one. It represents the superior valve of the stigmatic atrium and its caudal border is four-lobed, each lobe bearing a seta.

Procercus, or process of the eighth pleurite, one-segmented with a terminal seta.

Mesocercus (cercus) two-segmented, tapering, the first elongate dome-shaped, the second about the same length but more slender and with a terminal seta and covered with several small tubercles, each with an apical seta.

Ninth tergite divided into three lobes, two lateral and one median; median lobe<sup>1</sup> small and a little longer than wide with its caudal margin nearly straight and bearing a short but prominent seta at each caudo-lateral angle; outer or lateral lobes large, rounded and with a terminal seta; acrocercus below and its distal end shows between the lateral lobe and the median lobe just mentioned.

## 6. *Sphercheinæ*<sup>2</sup>

Egg-case carried by the hind legs and held on the under side of the body. Larva with head slightly inclined; ocular areas round and in groups of five, not closely aggregated; antennæ with points of insertion nearer the externo-frontal angles than those of the mandibles; epicranial suture very short, almost absent; labro-clypeus very much reduced, the epistoma apparently limiting the front margin of the head; mandibles stout, sharply pointed, furrowed internally and with inner teeth; maxilla palpiiform but with palpifer bearing an inner lobe or lacinia; labium with palpi and ligula short; labium and maxillæ inserted in a furrow on the under side<sup>3</sup> of the head; gula well developed and attaining the occipital opening. Eight complete abdominal segments, the ninth and tenth reduced. The type of breathing is pseudo-metapneustic and with poorly developed bifore spiracles. Seven pairs of short conical gills on the first seven segments. Cerci and prostyles present but reduced.

<sup>1</sup>This median lobe seems to articulate at its base and may be the remains of the tenth segment of the lower *Hydrophilidæ*.

<sup>2</sup>This subfamily is not represented in this country but is incorporated on account of its unique specialization.

## 7. **Hydrophilinae**

Egg-cases characterized by their horny mast and comparatively larger size. Larva with elevated head; antennæ with points of insertion farther from the externo-frontal angles than those of the mandibles; second segment without an antennal appendage; epicranial suture absent or very short; ocular area flat, elongate and closely aggregated although distinctly separated; both labrum and clypeus almost entirely reduced, the front margin nearly straight and with only a few small teeth. Mandibles prominent, sharply pointed, furrowed internally and with inner teeth; maxilla palpiform, slender, the stipes longer than the palpifer and palpus together, palpiger with an inner rudimentary lobe; labium with palpus longer than in the primitive genera, the second segment distinctly longer than the first; ligula present, labium and maxillæ inserted at the anterior margin of the under side of the head; gula reduced and not attaining the occipital opening. Legs provided with fringe of setæ. Eight complete, non-chitinized abdominal segments; ninth and tenth reduced. Type of breathing pseudo-metapneustic and with poorly developed bifore spiracles. Tracheal gills, if present, not well developed. Cerci reduced but two-segmented. Prostyles present or absent.

### **HYDROPHILUS** Leach

There are fewer species in this genus than there are in *Hydrous*, but the members of *Hydrophilus* are more equally distributed over the world. One of the four American representatives, *H. obtusatus*, occurs at Ithaca.

The well-known European species, *H. caraboides*, was one of Linnaeus' species and Roesel in 1749 knew some of its larval instars besides the pupa. Lyonet was the first to describe the egg-case and Schiödte later gave the entire life history. The egg-case and young larva of *H. obtusatus* were figured by Bowditch in 1884. He gave a very interesting account of its biology but did not observe the pupa. The full-grown larva and pupa were later described by Wickham but the figures are of little value and the descriptions meagre. Although it varies in size, it is our second largest hydrophilid and is intermediate, in this respect, between *Tropisternus* and *Hydrous*. The beetle is very clumsy and in no way approaches the two other genera of this subfamily in aquatic adaptation. It is most frequently found in leaf-filled pools, mud holes, at the water's edge under débris or clumps of grass, or in pools overgrown with vegetation. Several adults are often taken together in such situations, but only isolated specimens are usually recorded.

### **Hydrophilus obtusatus** Say

Plate I, Figures 1, 2, and 6; Plate VI

The egg-cases of *H. obtusatus* appear in late May and early June but are not often reported. The fact that they are usually covered with a



dead leaf makes it more difficult to see them. They float freely and are the most picturesque of all the egg-cases. A case was formed indoors on April 22 and, as there were no leaves present in the aquarium, it was placed in a mass of floating algæ. No definite air chamber such as is found in *Hydrous* is present. The eggs, about forty in number, are laid in a vertical position at the bottom of the case. Just behind the cap is a mass of loosely spun silk. The cap end is never covered by the leaf but the larvæ do not always emerge underneath it, as seems to be the rule in *Hydrous*. More often the escape is made at the other end.

The young larvæ fed readily on *Cyclops*, *Cypridopsis*, etc., and made several attempts to catch small tadpoles. Freshly killed tadpoles were placed within their reach but they evidently did not care for the dead food. According to Bowditch, they become full grown in about thirty days and spend the remainder of the summer and winter as pupæ, emerging early in the spring. Such an extraordinary length in the pupal stage may be true but it does not sound plausible nor is it always the case.

In July a mature larva was captured floating in the middle of a lagoon near the Biological Field Station. It was placed in a terrarium and on July 21 started burrowing down. After several attempts to form a suitable cell below the surface, it finally pupated above ground July 28. The process of transformation took less than an hour and a beautiful sea-green pupa resulted. Five days later the adult emerged. At the time of emergence the beetle was piceous above but its under side was light brownish in color.

EGG-CASE.—Whitish except brownish mast and plate at its base. Case without the leaf 9.2 mm.—18 mm. long, 9.8 mm.—11 mm. wide, and 7.8 mm.—9 mm. high. The horn-like mast, arising vertically from the top of the largest or cap end of the case, is from 7 mm.—11.8 mm. in length. It is enlarged at the base into a roundish plate about 4.—4.5 mm. high. The top of the mast is often bent forward and away from the case.

NEWLY HATCHED LARVA.—Length, 6.5–7 mm.; width at the thorax, 1.25 mm. Light brownish in color. Integument entirely pilose.

Head broadly ovate, constricted behind, elevated; fronto-clypeal suture well indicated at the sides; frontal sutures gradually converging but not uniting until they attain the caudal margin of the head; frons raised in the middle; gula reduced, arched, semicircular, and with the gular sutures prominent and confluent. Cervical sclerites present.

Labro-clypeus nearly symmetrical, reduced, with very small inconspicuous teeth at the anterior margin and a row of five small setæ equidistant from each other. Lateral expansions of epistoma similar and broadly rounded, overlapping the bases small short setæ along their margins.

Ocular areas in groups of six arranged in two parallel rows, the first three nearly vertically, while the posterior three are horizontally placed. The sixth area or outer one of the posterior row distant from the fifth. Articulating maxillary piece fairly well developed.

Antennæ slender, extending forward about as far as the tips of the mandibles; first segment much longer than the second and third together, slightly constricted near the base, a little crooked and with a few short conical spines on its inner surface; second segment bent inwardly a little, slightly longer than the terminal segment and with a disto-medial seta; latter segment more slender and possessing a few distal setæ.

Mandibles symmetrical,<sup>1</sup> prominent, elongate, sharply pointed at their tips and with their inner surfaces grooved; each mandible with two inner teeth, the proximal tooth smaller than the distal and slightly bifid; distal tooth furrowed on its inner surface, and the furrow is continuous with a furrow surrounding the proximal tooth.

Maxillæ slender and with joint-like palpifer; stipes swollen near its base, slightly bowed, longer than the palpifer and palpus together and its inner surface with a row of five setæ, the basal four fairly stout; palpifer with a small chitinous appendage bearing a terminal seta at its disto-medial angle; about twice the length of the 1st palpal segment but only very slightly wider; palpal segments all about the same width and bearing the relation of 7, 13, and 20; terminal segment with a single distal sense-cone.

Labium prominent, palpus nearly attaining the distal end of the stipes, its first segment short, the second the same width but about five times as long and with terminal sense-cones; ligula well developed, more than twice as long as the first palpal segment, cylindrical, only slightly tapering, chitinized except tip; palpiger four-elevenths longer than wide, sides parallel; mentum cordiform, anterior angles pronounced and acute; submentum extremely transverse, small and joint-like.

Prothorax narrower than the head, sides parallel; pronotum bearing a few scattered setæ; entirely chitinized except at the anterior margin and the sagittal line, which continues through the thorax; a large ventral sclerite present in front of the prothoracic coxæ.

Meso- and metathorax similar to each other, a little wider than but less than one-half as long as the prothorax, each with a pair of fairly large, irregular subtriangular sclerites and a lateral tubercle. A bifore spiracle present in each antero-lateral angle of the mesothorax while, corresponding in position to it, there is a small tubercle on the metathorax. Pro-mesothoracic and meso-metathoracic sclerites are present and are small, elongate, horizontal plates.

Legs about twice as long as the width of the thorax; segments beginning with coxæ bear the relation of 35, 12, 35, 25 and 15; tarsi well developed, claw-like, and each with two inner setæ, one dorsal to the other.

Abdomen with eight distinct segments, narrowed posteriorly, ninth and tenth rudimentary. The first seven tergites similar, each with two very much reduced, oval, chitinized patches on the proscutum, the first pair larger than the others, and four small but conspicuous tubercles in a transverse row across the posterior or second fold of the scutum, each bearing a seta. Each tergite consists of three transverse folds while the intersegmental membrane has only one; sternites with similar arrangement except that there is a longitudinal fold on each side of the three transverse folds. Seven pairs of rudimentary bifore spiracles and seven pairs of pleural appendages, equally long (0.48 mm.), on the first seven segments. A small dorsal tubercle at the base of the appendage. The eighth tergite represents the superior valve of the stig-

<sup>1</sup>In *H. glaucus* the mandibles are asymmetrical. The left mandible possesses only a single inner tooth.

matic atrium and bears a large, chitinized plate, somewhat dome-shaped anteriorly. Caudal margin of the eighth tergite is slightly quadrilobed, each lobe with an unchitinized tip and several distal setæ.

Procercus well developed, its first segment prominent, with a chitinous band partly surrounding it and a distal tubercle as well as a small terminal segment, bearing an apical seta. Mesocercus fairly prominent, chitinized, two-segmented, each segment with an apical seta. The chitinous plate in front of the mesocerci distinct and with two transverse rows of setæ arranged in pairs; the posterior row with one pair and the anterior row with three pairs; median lobe of ninth tergite rounded and with a ventral chitinized plate which tends to wrap around it. Acrocercus situated below each lateral lobe of the ninth tergite, and with two terminal tubercles, each bearing a seta.

FULL-GROWN LARVA.—Length, 25–27 mm.; width at the thorax, 5 mm. General color is brownish above and dirty white below. The chitinized regions are castaneous. When about ready to pupate, it takes on a greenish gray coloration, probably due to the color pigment of the pupa. The head measures 3.25 mm. in width and 1.99 mm. along the mid-dorsal line. First segment of antenna slightly longer than in first stage, about one-fifth the second. Labro-clypeus inconspicuously crenate. Mandibles stouter, blunter and with the proximal inner tooth not noticeably bifid. Lobe of palpifer very rudimentary; dorsal surface of mentum with scattered setæ and four lateral spines which are more prominent; ligula very slightly divided at distal end. Seta in the caudal angle of the mesoscutum prominent. Prostyle or anal appendages not noticeably longer (1.2 mm.).

PUPA.—Length, 15 mm. with cerci (curled up); width at the thorax, 8 mm. Sea-greenish except whitish tubercles, styli, cerci and tip of abdomen. Whitish parts become brown as emergence time approaches and metathoracic wings fuscous.

Head smooth; two supraorbital styli present; two small oval raised areas on each side of the epicranial suture near the vertex. Pronotum smooth, its cephalic margin concave. Styli arranged as follows: three equally long styli,<sup>1</sup> curving backwards, in a transverse row at the anterior margin at each side; a group of three others similarly arranged but decreasing in length towards the middle, just inside the latter; three in a longitudinal row at each lateral margin; a transverse row of ten at the posterior margin (more slender and less recurved than latter); two transverse rows near the middle; the anterior row with four styli, the posterior with three. Mesosoma and metanotum with a pair of styli in a transverse row. Metathoracic pterothecæ visible from above. Tarsi not ending in prominent spines nor tibiæ spinous on the outer side. A transverse row of six motory styli on the first seven abdominal tergites, the outer one on each side mounted on a tubercle. Second to seventh pleurites each with a stylus or a tubercle. Eighth tergite with two small, rounded tubercles at the posterior margin on each side of the median line and each bearing a short terminal stylus. Ninth segment terminating in two, superficially annulate cerci, which are 2.85 mm. long, divergent, tapering and bifid at their tips. Spiracles raised and prominent.

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<sup>1</sup>These pronotal styli on the front margin and middle region have no terminal seta.



**TROPISTERNUS** Solier

Although the adults appear to be closely allied to *Hydrous*, the differences found in the immature stages tend to strengthen the validity of this genus. The adults differ from *Hydrous* principally in their smaller size and in the structure of the maxillary palpi. They are the most common members of the Hydrophilinae and may be taken in almost any pool or lagoon. Although more active than most of the water scavengers the adults are easily captured by hand. *T. glaber*, *T. mixtus*, and *T. lateralis* are the representatives in this region. The former two strongly resemble each other but *T. lateralis* can easily be distinguished on account of the narrow yellow margin of the prothorax and elytra. *T. glaber* is by far the most abundant species. The genus is limited to America in its distribution.

Duges, 1884, was the first to give the characters of the immature stages. His descriptions of the larva and pupa of *T. lateralis*, collected in Mexico, were carefully done but his figures are not very helpful. Wickham, 1893, added the larva and pupa of *T. glaber*. The egg-case has apparently been unmentioned in literature. This seems strange as the cases, at least those of *T. glaber*, are very common at the commencement of the warm summer days.

**Tropisternus glaber** Herbst

## Plate VII

The egg-cases cannot be mistaken; the horny mast is peculiar to the subfamily to which this genus belongs; the case is not as long as the naked case of *Hydrous* and is not wrapped up in a leaf as is the case of *Hydrophilus*. Instead, it is fastened to a leaf, blade of grass, or any kind of vegetation present at the surface of the water.

The cap covers one end of the case and the mast is firmly attached to it. There are from eleven to twenty-two eggs contained within and the time of incubation is six to seven days. The main dates of development of an individual observed in 1914 were as follows:

May 25, egg deposited in the case; May 30, larva emerged; July 1, burrowed; July 10, pupated; July 14, adult emerged.

The young larvæ were placed in an aquarium where they fed readily on entomostracans and small tadpoles. The different molts were not observed. Only a few larvæ reached maturity, as the weaker individuals were quickly eaten by the stronger ones. During the latter part of June and the first few weeks in July many full-grown larvæ were taken out-of-

doors at the edge of the pools under stones, débris, or even some distance from the shore on the surface of the alga-filled pools. The larvæ are found all summer but this first generation of the year is the most abundant. The second generation begins soon after the adults emerge, the greatest number of egg-cases of this generation being found the first part of August.

Pupæ were secured about the same time of the year within their cells an inch below the surface of the bank or under stones. When transforming indoors, many of the pupæ did not form a cell below ground but changed at the surface. The cells formed were about 12 mm. wide, 10 mm. high and nearly round. The earth in the terraria was only about three-quarters of an inch deep so that the larva could be observed forming the cells next to the glass. The constant squirming of the larvæ made the cell walls firm. The legs, especially the fore legs, helped materially in shedding the pupal skin. The tarsi are bent back and the tibiæ used in pushing the skin off.

Upon emerging, the head of the beetle, the middle of the pronotum (the edges lighter), the scutellum, and the legs were brownish in color. The elytra were yellowish white and the abdomen whitish. It colored very rapidly and in about ten hours was entirely black above but slightly brownish below.

EGG-CASE.—Whitish, except brownish mast. The measurements of case, which is figured, were 9.3 mm. long; 4.28 mm. wide at the cap end; 5.3 mm. wide at the other end; and the mast 4.8 mm. long.

NEWLY HATCHED LARVA.—Length, 4.8 mm.; width at the thorax, 0.84 mm. Light brownish (fulvous). Entire integument covered with fine short hairs.

Head ovate; fronto-clypeal suture well indicated at the sides; frontal sutures gradually converging and uniting to form a very short epicranial suture; frons raised in the middle, nearly triangular and with a transverse impressed line near its basal third; gula reduced, arched and semicircular but flattened posteriorly; gula sutures prominent and confluent. Cervical sclerites present.

Labro-clypeus nearly symmetrical, reduced, with very small teeth, usually five, in the middle and one on each side of the latter five but removed a little; a transverse row of six setæ just inside the margin. Lateral expansions of epistoma similar, rounded but somewhat straight in front, only barely exceeding the labro-clypeus with a row of inconspicuous setæ on the inner side and overlapping the bases of the mandibles.

Ocular areas in groups of six and arranged in parallel rows, the first three nearly vertically while the posterior three are horizontally placed. The sixth or outer one of the posterior row is distant from the fifth and in some specimens is rudimentary.

Antennæ extending forward about as far as the tips of the mandibles and beyond the first segment of the maxillary palpus; first segment longer than the following two segments taken together but stouter than in the other *Hydrophilinæ*; second segment slightly more slender and with several short setæ in the membrane preceding the third

segment; latter still more slender, a little stouter than the second and with several distal setæ in addition to a small, two-segmented, finger-like appendage.<sup>1</sup>

Mandibles asymmetrical, prominent, elongate, sharply pointed at their tips, each mandible with two<sup>2</sup> inner toothed areas; the distal inner tooth on each well developed, bifid, their anterior margin minutely serrate, and their inner surface with a groove, which extends to the base of the mandibles; this latter groove separates the proximal inner tooth of each mandible into two, equal, flat teeth; those on the left mandible are much larger than those on the right and with a curved edge, which crosses the groove, slightly proximal to them.

Maxillæ with joint-like palpifer; cardo<sup>3</sup> small; stipes slender, swollen at the base, slightly constricted in the middle, longer than the palpifer and palpus together and its inner surface with a row of five setæ; palpifer only slightly narrower than stipes but less than one-fourth its length; a chitinous finger-like appendage at its interno-distal angle bearing a long seta and a microscopic lobe or sense-cone apically; palpus tapering and curving in slightly; the first segment small; the second about as long as the palpifer; the third a little longer than the latter and with terminal sense-cones.

Labium prominent, the palpus nearly attaining the distal end of the stipes, its first segment short, the second of the same width but much longer and with terminal sense-cones and setæ; ligula well developed, more than twice as long as the first palpal segment, cylindrical, only slightly tapering; palpiger a little longer than wide, slightly swollen; mentum subcordiform, anterior angles pronounced and sharply pointed; dorsal surface with numerous minute spines at its basal half; submentum extremely transverse and joint-like.

Prothorax nearly as wide as the head, angles slightly rounded; pronotum entirely chitinized except at the anterior and posterior margin and possessing a few scattered setæ besides a transverse row of six setæ in front and a transverse row of four in back; a large ventral sclerite present in front of the prothoracic legs. Sagittal line continuous throughout the thorax. Pro-mesotergal sclerites are present and are small, elongate and horizontal.

Mesothorax much shorter than the prothorax, about the same width and with a pair of fairly large, irregular, sclerites, each with a prominent seta caudally. Spiracular area with three small tubercles. A rudimentary bifore spiracle present in each externo-frontal angle.

Metathorax similar but slightly narrower and shorter and its sclerites more irregular caudally. A small pleural appendage present.

Legs more than twice as long as the width of the thorax; segments beginning with coxæ bear the relation of 16, 7, 16, 12, and 9; tarsi well developed, claw-like and each with two inner setæ, one proximal to the other and smaller.

Abdomen with eight distinct segments narrowed posteriorly, ninth and tenth rudimentary. The first seven tergites similar, each with two very much reduced, oval, chitinized patches on the præscutum, the first pair larger than the others, and four small but conspicuous tubercles in a transverse row across the posterior fold of the scutum, each bearing a long, colorless seta. Each tergite consists of three trans-

<sup>1</sup>Wickham, 1893, considers this appendage as one-segmented but remarks that it appears to be two-segmented.

<sup>2</sup>Duges, 1883, describes *T. lateralis* as possessing only one inner tooth. The terminal segment of the maxillary palpus is also small and cone-shaped.

<sup>3</sup>Wickham, 1893, said that he could not find the basal segment in his specimen although Duges had apparently observed it in *T. lateralis*.



verse folds while the intersegmental membrane has only one; sternites with similar arrangement except that there is a longitudinal fold on each side of the three transverse folds and a fourth indistinct transverse fold was observed in some specimens. The before spiracles at the tip of small tubercles. Both the epipleurite and hypopleurite bear a tubercle. The transverse row of tubercles is lacking on the second fold of the sternite but a single prominent tubercle is present on each side of the third fold as well as one behind the middle of the longitudinal fold.

The eighth tergite represents the superior valve of the stigmatic atrium and bears a large, shield-shaped, chitinous plate, which is slightly emarginate at the middle of its anterior border but more prominently so just behind the two middle lobes of the caudal margin of the eighth tergite. The structure of the atrium is very close to that of *Hydrophilus*. It differs from the latter principally by the fact that the two middle lobes of the hind margin of the superior valve are more distinct resembling the mesocerci and that the two anterior setæ of the plate in front of the cerci are set farther apart. The median lobe of the ninth tergite with two distal setæ. The prostyles are short, not exceeding the sides of the body, broad, rounded, and depressed.

**FULL-GROWN LARVA.**—Length, 14 mm.; width at the thorax, 3.2 mm. General color brownish above and dirty white below; chitinized regions reddish brown. Head dorsally with a yellow stripe on each side; ventrally with a median and two lateral pairs of yellow stripes; measures 2 mm. in width and 1.44 mm. along the mid-dorsal line. First segment of antenna longer in proportion than in the first instar, more than four times the second segment. Labro-clypeus nearly straight, often slightly crenate, and some specimens retain the most lateral tooth of the first instar on each side, but it is very inconspicuous. Mandibles with the outer spur of bifid inner tooth lacking. Lobe of palpifer very much reduced; dorsal setæ of mentum (about fourteen) arranged somewhat in a transverse ellipse; externo-frontal angles rounded but prominent and with a small outer seta; tubercles of abdomen prominent and each bearing a group of long, slender, terminal setæ.

**PUPA.**—Length, 12 mm. (curled up); width at its thorax, 5.6 mm. Entirely whitish except reddish brown eyes.<sup>1</sup> Head smooth, no supraorbital setæ, oval, raised areas on each side of the epicranial suture near the vertex very small. Pronotum smooth with middle lobes not prominent. Motory styli are long, fleshy and annulate, each bearing a terminal seta, slightly recurved and arranged as follows: three in a transverse row on each side near the anterior margin; four in the middle just back of the anterior margin, the two inner ones set back a little; six in a transverse row at the posterior margin (no corner styli); two on the basal half of each side; and two in a transverse row across the middle. Meso- and metanotum with a pair of transverse styli; scutellum well marked; metasternal spine long. Inner spur of metatibia very prominent. Tarsi not ending in prominent spines nor tibiæ spinous on the outer side. Metathoracic pterotheca visible from above. First to seventh tergites with a transverse row of four styli, second to seventh pleurites each with a stylus. Eighth tergite with two very small indistinct lobes at its posterior margin on each side of the median line and each bearing small stylus. Ninth segment terminating in two crooked, fleshy, superficially annulate cerci about 1.45 mm. long. Cerci diverge as far as their

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<sup>1</sup>A fresh pupa showed the eyes entirely white except the six pigment-spots of the ocular areas, which were grouped at hind margin of the head.

middle and then converge. They are slightly bifid and sharply pointed. On the outer side of the distal third are two small spines. Abdominal spiracles (second to sixth) large, uncovered and the area about them well chitinized.

#### ***Tropisternus sublævis* LeConte**

A specimen of this species was examined at the National Museum. It is very close to *T. glaber*. The proximal inner teeth of both mandibles are more reduced and the basal ridge of left mandible is lacking.

#### **Hydrous Leach**

The above generic name will doubtless be confusing to many because our representatives have for so long a period been known under the genus *Hydrophilus*. Here are included the largest beetles of the family and, in Ithaca, only one species is to be found, namely, *H. triangularis*. This is well known to collectors and because of its large size, measuring over thirty millimeters in length, can not be mistaken. Its specific name is evidently due to the triangular spots of yellowish brown hair on the abdominal sternites.

Adults have been collected during the warm spring and summer months under electric lights, toward which they often fly in large numbers. One specimen was captured as late as November 1 under an arc light. The most rapid swimmers of the family are included in this genus. It is clearly seen that their bodies are well adapted for gliding through the water with the least possible resistance.

European authors have paid a great deal of attention to *H. aterrimus* and *H. piceus*, especially the latter, not only to their life history but also to their biology in its various phases. The earliest mention of the larval and pupal stages was made by Frisch as far back as 1721 but his unique error of describing the larva upside down and therefore ascribing dorsal legs to it takes away part of its value. Miger and Lyonet follow about a century later and both papers are worthy of commendation. The life history of *H. aterrimus* given by Schiödte is presented in the usual careful way of the author.

The most complete work on the only American species considered is that of Dr. Robert Matheson of Cornell University, published in 1914. He has very carefully followed the entire life history of *H. triangularis* through all its stages from the egg to adult. Garman's paper in 1881 on the egg-case and larva was well written but did not include the entire life history. It was supplemented by Riley's paper in the same year.

**Hydrous triangularis** Say

Plate I, Figure 7; Plate VIII

It hardly seems necessary to go into the biology of this species. However, the main events occur as follows. The egg-cases are found mostly in June, and, although always attached to floating leaves or other débris, have never been reported as fastened to living plants. Over one hundred eggs are enclosed within it and the larvæ when newly hatched are very ungainly as compared with the full-grown larva. The usual two molts take place and the pupa appears in about one month. The duration of this latter stage is about eleven days.

EGG-CASE.—Light brownish with its mast and plate at base of mast almost black. It measures 24 mm. long, 15 mm. high, and about 22 mm. wide. The horn-like process, which arises from the cap end of the case, is almost at right angles with the upper side of the case and is usually 7–8 mm. long. Below the plate is a lunar-shaped opening which leads into a chamber below the eggs.

NEWLY HATCHED LARVA.—Length, 8 mm.; width at the thorax, 1.7 mm. Light brownish with appendages whitish darkening with age. Integument with fine dark hairs.

Head, without mouth-parts, 1.14 mm. long dorsally and 1.82 mm. long ventrally; 2.1 mm. in width; broadly ovate, large, depressed, strongly elevated; fronto-clypeal suture well marked; frontal sutures widely separated, converging only slightly and not uniting to form an epicranial suture; gula fairly prominent, arched, semicircular behind; gular sutures confluent and distinct.

Labro-clypeus reduced, with its anterior margin slightly concave and bearing a few microscopic projections towards each side. Lateral expansions of the epistoma similar, acute, not prominent.

Ocular areas in groups of six, elongate and arranged in two parallel rows, the first three nearly vertically while the posterior three are horizontally placed. The sixth or outer one of the posterior row distant from the fifth.

Antennæ three-segmented, exceeding the right mandible by almost the length of the terminal segment, and left by its last and half of its penultimate segment; first segment longer than the second and third together, almost as long as the stipes, bent inwardly near the base and fringed on the inside, except the basal third, with slender setæ; second segment swollen distally and not quite as long as the third, which bears no distinct terminal sense-cones.

Mandibles asymmetrical, prominent, sharply pointed at their tips and with their inner surfaces grooved; each mandible with a single inner tooth, the inner tooth of the right mandible with a large tooth on its anterior margin forming an unequally bifid tooth; the left mandible stouter and shorter than the right and with a membranous area in the region of the molar surface.

Maxillæ with joint-like palpifer; stipes slender, slightly bowed, longer than the palpifer and palpus together and its inner surface with a row of four stout setæ; palpifer with a chitinous finger-like appendage at its interno-distal angle; about the same length as each of the palpal segments but slightly wider; terminal segment of palpus with no distinct sense-cones. Articulating maxillary piece well developed.



Labium prominent, almost attaining the tip of the left mandible; submentum transverse and hinge-like; mentum longer than wide, arched below, its sides at basal half slightly concave but at its distal half convex, the fronto-external angles produced forward and prominent; palpiger much narrower than the mentum, its sides diverging anteriorly; ligula somewhat thimble-shaped, about the same size as the first palpal segment; the second segment of the palpus more than twice as long as the first and slightly convex on the outer side.

Prothorax narrower than the head; anterior margin nearly straight; proscutum represented by two, fairly large, somewhat triangular sclerites. Sagittal line present throughout thorax. Mesothorax slightly shorter than prothorax but just as wide; the mesoscutal sclerites more triangular and smaller. A small bifore spiracle<sup>1</sup> present in each spiracular area. Metathorax similar to latter but not quite as long.

Legs very long, about two-fifths longer than the thorax is wide; coxæ nearly as long as the femora, the latter with swimming fringes; tibiæ shorter than femora and three-sevenths longer than tarsi. The tarsi bear two inner setæ, one distal to the other; tarsi claw-like and well developed.

Abdomen with eight distinct segments, narrowed caudally, ninth and tenth rudimentary. The first seven tergites similar and each divided into three transverse folds, while the intersegmental membrane has only one. The second scutal fold bears a transverse row of four small tubercles. Epipleurite and hypopleurite each surmounted by a small tubercle, not distinctly separated but together forming an elongate lateral lobe. First five sternites with three transverse folds and a longitudinal fold on each side of them. Eighth tergite about as long and wide as the intersegmental membrane preceding. The dorsal region represents the superior valve of the stigmatic atrium and bears a reduced plate, the slender anterior arms of which enclose a median, elongate, non-chitinized area. The caudal margin of the eighth tergite is minutely crenate towards the sides and is rounded in the middle. The rudiments of the four lobes found in other Hydrophilinæ are weakly indicated. There are two small tubercles, one below and on each side of the middle lobe of this hind margin. Procerci fleshy and quite prominent. The mesocerci are fairly prominent, as well as the acrocerci. The median lobe of the ninth tergite is slightly bilobed. Lateral lobes not prominent. The prostyles, belonging to the tenth segment, are nearly as long as the seventh and eighth segments together (1.44 mm.) and are superficially annulate.

FULL-GROWN LARVA.—Length, 40–54 mm.; width at the first abdominal segment, 9–12.5 mm. General color grayish or dirty whitish except reddish brown head, sclerites, and legs. Head 6.5 mm. wide; 5 mm. long below; 3.1 mm. long above. Antennæ four-segmented,<sup>2</sup> a small segment about one-third the length of the third segment having appeared between the first and second segments of the first-stage antenna. Lateral expansions of the epistoma not prominent. Mandibles with tips and inner teeth blunt. Terminal segment of maxilla only about half the penultimate in length. Ligula dome-shaped, much shorter than the first palpal segment, which is a little more than one-half the second segment of the maxillary palpus. Dorsal surfaces of the mentum and palpiger with a few scattered setæ.

<sup>1</sup>Matheson described a pair as present on the metathorax also but none were seen in the specimens which I examined.

<sup>2</sup>D'Orchymont considers that Schiödte was mistaken when he called the antenna of *Hydrous* four-segmented. There are surely four in *H. triangularis*.

Thoracic segments wider than the head. Folds and lobes of whole body much more distinct than in other stages. Legs about five-sixths as long as the thorax is wide. Abdomen spindle-shaped.

PUPA.—Length, 24 mm. with cerci (curled up); width at its thorax, 14.5 mm. Whitish. Head smooth, only one small posterior supraorbital stylus noted; two small, oval, raised areas on each side of the epicranial suture near the vertex. Pronotum smooth, its cephalic margin concave. Styli arranged as follows: three long styli, curving backwards, in a transverse row at the anterior margin on each side; eight shorter ones near the posterior margin, besides two very small ones just inside the inner two styli; a few other scattered ones. Mesonotum and metanotum with a pair of styli in a transverse row. Scutellum well marked. Metasternal spine long. Inner spur of metatibiæ very prominent. Metathoracic legs long nearly attaining the end of the body. Tarsi not ending in prominent spines nor tibiæ spinous on the outer side. Metathoracic pterothecæ visible from above. First to seventh abdominal tergites with a transverse row of four styli, the outer one on each side mounted on a tubercle. The styli just behind the spiracles longer than the others and curved backwards. Second to seventh pleurites each with a stylus. Eighth abdominal tergite with two small rounded tubercles at the posterior margin on each side of the median line and each bearing a short terminal stylus. Ninth abdominal segment terminating in two superficially annulate cerci about 2.5 mm. in length and with a prominent short, ventral spine between their bases. Abdominal spiracles oval, uncovered and prominent (second to sixth visible).

## 8. Hydrobiinæ

Eggs usually enclosed in a silken case with a prominent projection but sometimes laid in a mass with a loosely applied covering of silk (*Cymbiodyta* and *Paracymus*) or held on the under side of the body by the elytra (*Epimetopus*, *Chætarthria*?) or hind legs (*Helochares*).

Larva with head elevated. Antennæ with points of insertion situated farther from the externo-frontal angles than those of the mandibles; second segment with an antennal appendage. With or without an epicranial suture; ocular areas flat, elongate, in groups of six, closely aggregated; labrum and clypeus both reduced and united, the anterior margin more or less toothed; mandibles prominent, sharply pointed and with inner teeth; maxillæ palpiform and stipes with a rudimentary inner lobe. Labial palpi longer than in other subfamilies; the second segment distinctly longer than the first. Ligula present except in *Berosus* and *Laccobius*; labium and maxillæ inserted at the front margin of the under side of the head<sup>1</sup> and not attaining the occipital opening. Eight complete abdominal segments and a rudimentary ninth and tenth; the chitinization is entirely lacking, except the dorsal plate of the eighth segment and chitinized patches on the præscuta. Cerci two-segmented but reduce 1 (absent in *Berosus*). Type of breathing is pseudo-metapneustic except in *Berosus*, which possesses tracheal gills and a rudimentary stigmatic atrium. All genera have poorly developed bifore spiracles.

<sup>1</sup>Vestiges of furrowed condition in *Berosus* and *Laccobius*.

**LACCOBIUS** Erickson

This genus is evidently represented by one species and a variety in New York State but the variety has not been described to date. The more common or silvery species is apparently the one which Randall named *agilis* and was first recorded from Maine. The other, which seems to be a new variety, is less common and of a general brown color lacking the pale triangular space in front of the eye. Both species seem to have a great diversity in size. *L. agilis*, although very abundant in its habitat, has been little collected in Ithaca, only three specimens having been recorded to the date of my first observations in the fall of 1913. It is found frequently in Cascadilla Creek either on mud flats or on stone ledges which border its waters. Specimens are most easily collected by washing the vegetation and shore with the creek water, using the hand as a dipper. When thus disturbed, the little beetles will be noted swimming speedily towards the shore and presently observed burrowing in the mud or hiding in the vegetation until they are entirely concealed from view. The most abundant vegetation in their environment seems to be the alga, *Cladophora*, which is especially common in our swiftly flowing streams.

The brown variety frequents mud holes and swampy lands but, with that exception, its habits are very similar. The life history of this genus is practically unworked<sup>1</sup> except by d'Orchymont, who gives what he considers the generic larval characters of *Laccobius*<sup>2</sup> sp. ?, an immature specimen of which he obtained. This is accompanied by a dorsal view of the head.

**Laccobius agilis** Randall

## Plate IX

The egg-cases of the brown variety have not been taken as yet in the field but those of *agilis* are very abundant at certain seasons of the year. They have been collected in April, May, June, and July. The most natural place for the cases is apparently at the water line in *Cladophora* or attached to the roots or blades of grass. They are frequently attached to the rock-ledge itself and, in such condition, are hard to remove without breaking open the case.

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<sup>1</sup>Dr. Adam Böving, however, gave me the following data as to the rearing of *Laccobius*: "Dr. Wesenberg-Lund has not yet published anything about it; Schlick has published a note in the Danish Entomologiske Meddelelser Vol. 4, 1894, p. 304 and also in a later volume, as far as I remember Vol. 6; in the same periodical Vol. 5, 1895, p. 12, you will find a note that E. Rosenberg has taken and reared the *Laccobius* larva to adult."

<sup>2</sup>It differs mainly from *L. agilis* in that the right mandible possesses only two inner teeth. This is also true of the undescribed larva of *L. minutus*.



From two to eleven eggs are in each case and these hatch in seven to eleven days. When leaving the case, the larva seems to select no particular place of exit. Specimens have been noticed emerging from a hole in the egg-case proper; others from an opening made at the outer edge of the basal cavity of the filament (see Plate IX). Many larvæ have been collected. They may be observed on the *Cladophora* and stones just where the water laps the shore, half in water and half out, as is the customary position of most pseudo- and metapneustic Hydrophilidæ. The number of instars seems to be three.

About the middle of June 1915 several fairly mature larvæ, which were hatched from eggs taken April 29, were placed in the usual terrarium but, as they did not seem quite ready for pupation, they were replaced. On June 22, while on a special trip to the best collecting grounds of *Laccobius*, about fifteen larvæ were taken. The largest of these were placed in the terrarium at the same time as one of the reared larvæ but in different receptacles. On the morning of June 30 one of the latter lot had pupated as well as one of the larvæ of April 29. Upon comparing the larval skins and pupæ, they proved to be identical and, so, one pupa was allowed to come through but the other was preserved with its larval skin. Thus, the complete life history was secured. One of the larvæ pupated on the surface of the earth, while the other made a cell (6 mm. long, 3 mm. wide, and 3 mm. deep), just below the surface. The dates of development were as follows:

April 29, egg-case found; May 4, larvæ hatched; June 30, pupated; July 3, adult emerged.

Soon after emerging the adult's head, prothorax, and scutellum were colored very dark green, except the lateral margins of the pronotum, which were silvery gray with dark green or blackish spots sparsely distributed. The coxæ, trochanters, and femora were gray, but the tibiæ and tarsi were luteous. The exact time before complete coloration took place was not noted, but it was longer than with other species.

EGG-CASE, without its filament, nearly spherical, often a little broader than long, its size varying as does that of the filament. Measurements show the case proper to be from 1.4–1.6 mm. in diameter and the filament from 7–10 mm. in length. The latter is continuous with the covering of the case and is therefore hollow, the cavity at its base being quite large, as figure 11, Plate IX, indicates.

NEWLY HATCHED LARVA.—Length, 2 mm.; width, 0.288 mm. Whitish (transparent at first), except the chitinous portions, which are light brown darkening with age. Integument dotted with slightly recurved spines arising from minute tubercles.

Head quadrangular, elevated slightly; labro-clypeal suture weakly indicated by a crease in the integument; frontal sutures parallel, extending to the caudal margin of the head and not uniting to form the epicranial suture; frons quadrangular; hypo-

stomal margin prominent and there is a furrow in front of it but the labrum and maxillæ are united at the anterior margin; gula reduced; the gular sutures fairly prominent and confluent and its anterior margin with two long setæ on each side of its median line. The cervical sclerites present.

Labro-clypeus asymmetrical, irregularly toothed in the middle with three teeth and with two, prominent, blunt setæ projecting from the ventral side. Lateral expansions of epistoma differing greatly; the right rounded, overlapping the base of the right mandible; the left overlapping the left mandible and rounded but bearing a row of stout setæ which become shorter toward the median line (five or six are very prominent).

Ocular areas in groups of six but rather indistinct. They are arranged in two parallel rows, the outer one of the posterior row a little out of line and more anterior.

Antennæ fairly stout; the first segment about two-thirds as long as the second, slightly constricted in the middle and bearing at least two dorsal sensory pits; second swollen a little and bearing a small, colorless, finger-like antennal appendage in addition to the sense-cones at the latter's base, and a long inner seta, arising from a tubercle, as well as a few less prominent ones; third segment very small, almost as wide as long, a little longer than the appendage of the second segment, and bearing three long setæ and several sense-cones at its extremity.

Mandibles asymmetrical, fairly prominent and stout, sharply pointed at their tips, and toothed on the inner side; right mandible bears three inner teeth, decreasing in size from the cephalic to caudal one; the left has two toothed areas on the inner side, both of which present a pectinate region dorsally, in addition to a tooth.

Maxillæ with joint-like palpifer; stipes large, swollen, tapering slightly from base to apex, longer than the palpifer and palpus together and its inner surface provided with short, stiff setæ, and several longer stout setæ at intervals; the more slender setæ are present at the externo-distal angle; palpifer small, a little wider than long, bearing an inner rudimentary lobe, possessing a seta and sense-cones, below which is a slender seta; palpus with first segment about one-half the second while the third is a little longer than the first two and more slender and more cylindrical; the terminal segment possesses a group of sense-cones at its tip; articulating piece of maxilla well developed.

Labium small and with only its palpi exceeding the labro-clypeus; mentum and palpiger very small; both segments of the palpus are cylindrical, the second about three times as long as the first, more slender and with its tip possessing a number of sense-cones; ligula absent; palpiger has two setæ on its anterior border near the median line; submentum very indistinct.

Prothorax very slightly narrowed in front, larger than the head; pronotum entirely chitinated, except the sagittal line, with a transverse row of setæ (about ten) just a little posterior to the cephalic margin, several others on the sides. Meso- and metathorax a little wider and shorter than the prothorax. Mesoscutum and metascutum both represented by two subtriangular and very much reduced sclerites, each having a seta in their caudo-medial angle. The mesonotum has two smaller oval sclerites<sup>1</sup> just lateral of the median line and posterior to the cephalic margin. The spiracle at the tip of a little conical tubercle<sup>2</sup> in each antero-lateral angle of the mesothorax two-fifths as long as the thorax is wide.

<sup>1</sup>Probably homologous with the cervical sclerites.

<sup>2</sup>Tracheo-branches of d'Orchymont.

Legs fairly long, with tibiae nearly as long as, but a little more slender than, the femora; femora shorter than the small coxae; tarsi well developed, claw-like, almost as long as the tibiae, with two inner setae one distal to the other.

Abdomen with eight prominent segments, slightly narrowed caudally, ninth and tenth rudimentary. The first seven similar, each with two very much reduced, oval, chitinized patches on the praescutum near the cephalic margin on each side of the median line, and four prominent tubercles in a transverse line across the posterior fold of the scutum, each bearing a seta. Each tergite seems to consist of a praescutum, scutum divided into two transverse folds and posteriorly a very narrow scutellar fold that continues to the spiracular part of the tergite; sternites have similar corresponding folds. The eighth tergite represents the superior valve of the stigmatic atrium, bears a large chitinous plate,<sup>1</sup> which is about as broad as long. The caudal border of the valve is chitinized in part, possesses setae and presents a bilobed appearance. Procercus one-segmented,<sup>2</sup> subconical with a chitinous band on the inside and a group of three setae arising dorsally from tubercles on the apical half. Mesocercus two-segmented and chitinous, the first segment elongate, dome-shaped, bearing a central dorsal seta; the second very small, papilliform, and bearing a terminal seta. Between these two segments in the membrane there are several sense-cones.

Ninth tergite is divided into three lobes, two lateral and one median. The median lobe is irregularly dome-shaped with a chitinous plate nearly covering the upper surface while the lateral lobe possesses a chitinous region from which arises two setae mounted on tubercles. Two pairs of setae, arising from tubercles, are present on the membranous area just lateral to the plate, the anterior pair being contiguous with the plate. A ventral pair may be seen through the membrane, anterior and in line with the other two. Acrocercus present on the under side of the lateral lobe and terminates in two setae mounted on tubercles.

FULL-GROWN LARVA.—Length, 5.8 mm.; width at the second to fourth abdominal segments, 1.5 mm. The general color is grayish brown or dirty white. The head, which is 0.3 mm. in length and a little less in width, is often retracted under the pronotum as far as the ocular areas. First segment of antennae little less than the second in length. Finger-like appendage of second segment about one-half the size of the third, which has become more elongate. Mandibles much stronger. The smallest inner tooth<sup>3</sup> of right mandible is smaller in comparison with the other teeth. Maxillae more developed; stipes larger and considerably longer than palpus and palpi together. Legs not as long as thorax is wide. Viewed from the side, there seem to be three lateral regions or tubercles on each abdominal segment; the dorsal and ventral lateral regions of the intersegmental membrane are reduced so that only the middle one is prominent.

PUPA.—Length, 3.6 mm. (curled up); width at its thorax, 2.9 mm. Whitish. Head smooth and bears two supraorbital styli on each side. Pronotum smooth, its cephalic margin lobe-like in the middle. The styli are arranged in transverse rows as follows: ten at the anterior margin, four in the middle at the posterior margin, the two middle ones being shorter than the other eight and the most lateral one on each

<sup>1</sup>A central colorless seta noted in some specimens and in *L. minutus* the anterior border of the plate is emarginate.

<sup>2</sup>D'Orchymont, because a terminal papilliform tubercle bearing a seta is present, considers that it may be two-segmented. The condition in *Hydrophilus obtusatus* tends to verify his opinion.

<sup>3</sup>Indicates a tendency to disappear. *Laccobius minutus* has only two inner teeth on right mandible.



side a little anterior. Mesonotum and metanotum with a pair of transverse styli. Inner spur of metatibia fairly prominent. All tarsi ending in a spine and all tibiae spinous on the outer side. First to seventh tergites with a transverse row of four subequal styli; the outer one on each side arising from prominent tubercles; second to seventh pleurites each with a stylus; eighth segment has two, small, cereal-like lobes, projecting dorsally. Ninth segment has a pair of cerci, which are about four times as long as the latter lobes and project backwards, diverging about  $45^{\circ}$ . The externo-caudal angles of the ninth segment are prominent and acute. The spiracles are exposed and well defined.

### BEROSUS Leach

Schiodte gave the complete life history of *B. spinosus* and later the larval differences of *B. signaticollis*. Brocher described the egg-case and young larva of *B. ariceps* (= *signaticollis*) and, although he did not rear it, considered that it could be no other species because of its size.

At least two species, *B. peregrinus* and *B. striatus*, occur in the vicinity of Cayuga Lake and doubtless others would be found if more time could be devoted to their study. These two are fairly distinct; the latter is separated from the former by its usually larger size and by the two small teeth, instead of only one, at the middle of the notch of the fifth abdominal sternite. The carination of the abdominal sternites of the male *peregrinus*, often used as a character of separation, seems to be quite variable in the specimens examined.

The beetles may be taken from early spring until late fall but are most frequent in May and late August. They are hardly ever taken in swift waters but inhabit small pools with an abundance of moneywort, *Chara*, *Elodea*, cut-grass, alga, etc. The fact that they are good swimmers requires the use of nets, in contrast to hand collecting so profitable for most of the other genera. The net must be drawn through the water rapidly for, as soon as disturbed, the beetles quickly dodge down to the bottom of the pool and in a moment are buried in the mud. At times many specimens may be gathered by pulling the vegetation out of the water quickly and looking it over carefully. They do not easily escape when thus taken, as they are very clumsy when out of water.

In the aquarium, they were observed feeding on the decaying leaves of moneywort, attacking both the upper and under side and eating holes entirely through. While watching them feeding, a peculiar, almost incessant action was noted. The beetles, holding on to the plants with their two anterior pairs of legs, kept sweeping the swimming hairs, which fringe the tarsi and tibiae of the hind legs, down and forward across the film of air covering the abdomen. Just what the function of such a

procedure may be is a question. Possibly it may serve to aerate the film of air, thus accounting for their ability to remain below the surface almost indefinitely. Stridulation is very pronounced and Brocher considered it in detail.

About thirty egg-cases were laid the middle of April in the aquarium on alga and moneywort below water. They somewhat resembled miniature chestnuts in form, and each contained from two to four eggs.

The first egg-cases noted out of doors were found May 9 in a small pool on South Hill. The submerged *Carex* was spotted with the white cases and apparently the dead plants were preferred. In a pool where no vegetation was present the cases were laid upon the under side of sticks and stones. Although more abundant in the egg-laying seasons, common to the family, yet the cases were found during the entire summer.

The larvæ on hatching break through the case at no particular place. However, the most common point of exit was between the base of the flap and the cap. The larvæ were very weakly chitinized in comparison with the larvæ of other genera. They spend most of their time crawling through the strands of algæ or in the débris at the bottom of the aquarium. The larvæ are the most difficult of the whole family to locate, due primarily to the fact that they breathe by gills. They live at the bottom of the ponds and farther from the shore than is the custom of the other larvæ. The débris clings to them and they, therefore, closely resemble their surroundings.

### **Berosus peregrinus** Herbst

#### Plate X

Several egg-cases of *B. peregrinus* were found the latter part of July and the spinning and egg laying proceeded in the following order.

1. An under layer of compact silk, composed of criss-cross strands, laid down continuous with the flap.
2. One egg deposited lengthwise towards one side and covered with a loosely applied silk.
3. Second egg placed near the opposite side, parallel to the first egg and covered with a loosely applied silk.
4. Third egg laid between the first two eggs.
5. A cap of compact silk, composed of criss-cross strands of silk laid tightly over the egg-case proper.

EGG-CASE, as a whole, somewhat chestnut-shaped. The cap end is flat with a narrow flare outside the egg-case proper; and the cap, which covers this surface, is continuous with the slender filament that extends upwards. The other end is rounded.

The case proper measures 1.6 mm. high, 1.2 mm. wide, and 0.323 mm. long. The filament averages about 4.5 mm. long, its width of 0.13 mm. is usually constant and its sides are parallel.

NEWLY HATCHED LARVA.—Length, 1.9 mm.; width at its thorax, 0.32 mm. Whitish, with chitinized areas very slightly light yellowish. Integument dotted with minute setæ.

Head ovate, elevated; fronto-clypeal suture very indistinct; labro-clypeal suture fairly well indicated; frontal sutures gradually converging as far as the posterior third and then slightly diverging, not uniting to form an epicranial suture; gula reduced, polygonal, posteriorly somewhat rounded; gular sutures contiguous for a long distance; labium and maxilla inserted at the anterior margin of the head but the signs of the groove are still present and the hypostomal margin distinctly marked off; cervical sclerites present.

Labro-clypeus small, projecting forward rather prominently, arched, with seven small teeth and four equidistant setæ. Lateral expansions of epistoma differ greatly; the right rounded, reduced and not exceeding the labro-clypeus; the left prominent, exceeding the latter, rounded and bearing a row of setæ on its anterior margin.

Ocular areas in groups of six and closely aggregated, oval, arranged somewhat in a circle, each area equidistant from the other except the sixth area which is about twice the distance from the first area than it is from the fifth.

Antennæ short, not exceeding the mandibles, with their points of insertion widely separated but inside those of the mandibles; first segment a little longer than the second, constricted at its basal half and with a small finger-like appendage, provided with colorless apical setæ, at its interno-frontal angle; second segment swollen, only slightly narrowed distally and bearing a small, colorless, finger-like antennal appendage, which is nearly as long as the third segment; the latter small, a little longer than wide, and with terminal setæ and sense-cones.

Mandibles asymmetrical, prominent, sickle-shaped, sharply pointed at their tips, and toothed on the inner side; right<sup>1</sup> mandible with two inner teeth, the distal tooth much larger than the proximal one, and the vestige of a third more proximal tooth apparently represented by a minute spine; left mandible slightly notched on the inside towards the tip and with a complicated set of inner teeth, the distal one the largest and triangular; molar area with a small distal, spine-like projection.

Maxillæ with joint-like palpifer; stipes large, swollen, tapering very slightly, longer than the palpifer and palpus together and its inner surface provided with a row of five, stout, equidistant setæ; two slender setæ near the externo-distal angle; palpifer short, much wider than long, bearing an inner rudimentary lobe, provided with a long seta and a sense-cone, below which is a stout seta; palpus tapering; the first segment only about one-half the palpifer in length; the second much longer and with an externo-distal seta; terminal segment two-sevenths shorter than the latter and with distal sense-cones, in addition to an inner seta.

Labium small, with only the palpi exceeding the labro-clypeus; submentum small and transverse; mentum transverse with its anterior angles rounded; palpiger rather quadrate, narrower than latter and about the same length, slightly divided anteriorly in the middle and each half bears the two-segmented palpus; first segment of latter short, the second segment nearly three times as long and with terminal setæ; ligula absent.

<sup>1</sup>B. *spinosus* has a similar right mandible.



Prothorax rounded at the sides, about the same width as the head; anterior and posterior of pronotum non-chitinized; rest weakly chitinized except along the sagittal line; prosternum weakly chitinized in front of the coxæ; mesothorax and metathorax about equal to each other in size, shorter but slightly wider than the prothorax. Sclerites are not discernible. The pleural lobes are each surmounted by a seta arising from an elongate cylindrical structure (see figure 5, Plate X). A spiracle present in each externo-frontal angle of the mesothorax.

Legs long, about one-half again as long as the thorax is wide; coxæ transverse; femora and tibiæ about the same length; tarsi well developed, claw-like, one-fourth shorter than the tibiæ and with two inner setæ. The two anterior coxæ are closer together than the four posterior coxæ, which are about the same distance apart.

Abdomen with eight distinct segments, narrowed and slightly lengthened posteriorly, flattened above and arched below. The first seven tergites similar; indistinctly divided into two folds, while the intersegmental membrane has only one fold; each pleurite protrudes and bears a long, slender, tracheal gill, the length of these seven pairs of gills increases posteriorly. The second scutal fold has a transverse row of four setæ, each arising from an elongate cylindrical structure (similar to those on the pleurites of the thorax). Another seta, with such a structure at its base, present on the dorsal side of each gill and slightly removed from the base of the gill. Spiracles are at tip of small tubercles. The sternites have similar folds but no tubercles are discernible. Eighth segment short, cylindrical and with two small spiracles<sup>1</sup> on the middle of its dorsal surface and a few posterior setæ. The anus terminates this segment.

FULL-GROWN LARVA.—Length, 5.6 mm. (not counting the gills); width at the second abdominal segment, 1.68 mm. Pale yellowish with chitinized areas yellowish brown. Head, 0.576 mm. wide, 0.36 mm. along the mid-dorsal line. First antennal segment much longer and about one-half again as long as the second segment. The whole antenna more slender. Labium very indistinct. Body gradually widened as far as the second abdominal segment and then narrowed. Segmentation is much more pronounced as is the chitization also. Mesothorax with two reduced subtriangular sclerites. Two small horizontal pro-mesotergal sclerites present. Mesothoracic spiracles distinct and meso- and metapleurites each with a prominent wart-like tubercle corresponding in position to the gills of the segments. Præscuta of metathorax and first four abdominal segments visible. Legs much shorter, not as long as the thorax is wide.

Peculiar structures noted at base of setæ on posterior fold of abdominal scuta replaced by small but distinct, rounded tubercles. The gills are much shorter in proportion to the body and possess no dorsal seta near their bases.

PUPA.—The characters used by Schiödte in his pupal key are as follows: "Motory styli of abdominal tergites in fours; abdominal tergites with a small lateral tubercle on each side; spiracles not concealed; abdominal pleurites not distinctly separated from the tergites; styli of pleurites very short and conical; lateral styli of abdominal tergites very long and slender; prothoracic styli long and slender; cerci elongate, tapering, crooked and distally multiannulate." The figure shows twenty-six pronotal setæ or two more than is characteristic of the Hydrobiinæ.

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<sup>1</sup>The position of these spiracles recalls the position of those found in the pseudo-metapneustic Hydrophilidæ and probably indicates the degeneration of that type.

**Berosus striatus** Say

The stages of this species are very close in form to those of *B. peregrinus* and a separate description is unnecessary. The left mandible of the larva is quite similar to that of *peregrinus* but the right one has only the distal inner tooth well developed. The other two teeth are very rudimentary. As both the species belong to the same subgenus, *Berosus*, this character evidently is not one of subgeneric significance. Larvæ in the National Museum of *B. ariceps* (= *signaticollis* Charp.), which belongs to the same subgenus, possess the *peregrinus* type of mandible but have the labro-clypeus untoothed, rounded and short. The labro-clypeus of *B. striatus* is similar to *peregrinus* but the number of teeth varies from three to six.

**CHÆTARTHRIA** Stephens

Four species have been described from this country. *C. atra* LeConte, 1883, however, is the local species near Cayuga Lake and is very rare. In the field it could easily be mistaken for *Ancæna* and *Paracymus* but is usually smaller and noticeably hemispherical in shape. Closer examination clearly distinguishes it. The first segment of the antennæ is elongate and flattened. The ventral plates, fringed with appressed setæ and concealing the first two abdominal sternites, constitute the most striking characters of this genus.

The life history has not been observed. The structure of the abdomen possibly indicates that the egg-cases may be held on the ventral side of the female, somewhat in the same manner as in *Epimetopus*.

**HYDROBIUS** Leach

One experiences little difficulty in separating *H. fuscipes* and *H. globosus*, the two species which are present in the Cayuga Lake basin. As the name *globosus* suggests, this member is strikingly globular in form, while *fuscipes* is much flatter and more elongate. Both are almost entirely black in color but the reddish brown legs of *fuscipes* are characteristic of that species. They are not very often taken together, although they have been recorded from similar habitats. *H. globosus* seems to prefer the banks of rapidly flowing streams or spring-fed pools, filled with leaves or vegetation, while *fuscipes* abounds more often in stagnant waters. However, where the leaf-filled pools tend to become stagnant both species usually occur.

Only the life history of the holarctic species, *fuscipes*, has been worked out but many authors have written about it. Cussac, 1855, gave the first account of the egg-case and Schiödte, 1862, added the remaining stages. Miall, 1895, contributed an interesting account of its biology but Balfour-Browne, 1910, must be credited with the most comprehensive treatise on the species. As yet, a complete description of the pupa has not been presented.

The egg-cases of both species are the first of the family to be observed in the spring. The earliest record was April 16 for *H. fuscipes*. The egg-laying continues in full force until the cases of *Tropisternus* and various others begin to appear. Then a diminishing in the number of cases takes place. However, the cases may be taken all through the summer and the middle of August brings the greatest number again. This latter statement is practically true of *globosus* also. The cases of *fuscipes* are more frequently found away from the bank, attached to floating vegetation, while those of *globosus* are placed in moss or in mud at the shore-line and usually entirely concealed, except the cap end.

#### **Hydrobius globosus Say**

##### Plate XI

In contrast with *fuscipes*, *H. globosus* is uniformly abundant throughout the entire summer. Adults gathered in the spring were placed in an aquarium-terrarium. On April 16 several cases were observed buried in the mud away from the water-line and only the cap and flare were showing. To the casual observer this white silk would resemble mould.

The next day one of the specimens was seen working on an uncompleted egg-case. The cap had not been made and there were only nine or ten eggs within it. Upon being disturbed, the beetle stopped spinning but almost immediately recommenced. More eggs were being laid and this process was interrupted only when the beetle wished to apply the inner loose covering of silk. This process of adding the full complement of eggs required about half an hour and another half-hour was spent in sealing up the opening. It took over an hour to make the broad flare and nearly an additional hour adding silk here and there, apparently making sure the case was properly sealed. Not only did it complete this one case but another smaller case was soon formed next to it and the flares of both fastened together.

The number of eggs varies from thirteen to twenty-five but the average number is twenty. The young larvæ come out the cap end, breaking through rather than pushing off the cap. No attempt was made



to rear any of them but they were very cannibalistic, constantly attacking each other. About twenty-five were left for several days in the same jar and only one larva survived. Some fed readily on the *Cyclops* in the jar but they were too ravenous to be satisfied.

A number of larvæ, apparently full grown, were placed in terraria but they would not transform. They burrowed down, making galleries all through the earth, and even formed cells but never pupated. There they lived for several months without food. All stages were found throughout the summer and, in early spring, the partly grown larvæ were frequently taken under stones, leaves, or in moss. There they were, half in water and half out, lying in wait for their prey.

EGG-CASE, proper, nearly spherical and about 4 mm. in diameter. A flat, round cap closes the upper end of the case and it measures 2 mm. across. The flare, which is continuous with the cap, varies, but one half of it is usually quite broad while the other half is narrow.

NEWLY HATCHED LARVA.—Length, 4.5–5 mm.; width at the thorax, 0.7–0.8 mm. Whitish, with light, yellowish brown, chitinated areas. The integument is covered with small, fine, brown, setæ.

Head quadrangular, 0.6 mm. wide and 0.528 mm. along the mid-dorsal line; fronto-clypeal suture weakly indicated; frontal sutures irregular but converging gradually and uniting to form a short epicranial suture; frons shaped somewhat like an arrow-head; cervical sclerites present; gula reduced, pentagonal, rounded posteriorly; the gular sutures prominent and confluent; articulating maxillary piece distinct.

Labro-clypeus prominent, asymmetrical and with five distinct, acute teeth; the outer tooth on the left set apart from the other four teeth, which are equidistant; six setæ present, one on each side of each tooth. Lateral expansions of epistoma not exceeding the labro-clypeus, rounded and each with a row of setæ at the anterior margin.

Ocular areas in groups of six but rather indistinct. They are arranged more or less in a compact circle. The anterior three with their axes more longitudinal while the posterior three have their axes more horizontal and the last, or sixth, area is more remote than the others, which are nearly equidistant from each other.

Antennæ fairly short, not exceeding the mandibles; just about attaining the distal end of the palpifer; the first segment constricted slightly in the middle and about the same size as the second; the second segment swollen with a small, colorless, antennal appendage and several sense-cones at its externo-distal angle; a long, slender, interno-distal seta present; third segment very much smaller than the latter and provided apically with sense-cones, besides two long, slender setæ.

Mandibles symmetrical, prominent, stout, sharply pointed at their tips, and each with three well-defined inner teeth. The most distal tooth is the largest, the middle one a little smaller, and the proximal one considerably smaller. The molar area is smooth and rounded.

Maxillæ with joint-like palpifer; stipes stout, tapering slightly, with a row of five setæ on its inner surface; palpifer with a slender chitinous appendage, longer than the first segment of the palpus and bearing a terminal seta at its disto-medial

angle; a single inner seta near its base; palpi shorter, gradually tapering; the first segment narrower than the palpifer and only about one-fourth the length of the second segment; the third is a little shorter than the second and provided with terminal sense-cones.

Labium extending forward almost as far as the tips of the mandibles; the first segment of the palpus short; the second segment about four times as long but nearly the same width and bearing several terminal sense-cones; ligula prominent, slender and almost twice as long as the first palpal segment; palpiger quadrate with sides slightly rounded; two long setæ in the membrane at the base of the ligula; mentum slightly wider than palpiger, longer than wide and constricted a little in the middle; its dorsal surface with numerous short spines towards the sides and in the middle; the submentum extremely transverse and joint-like.

Prothorax with sides rounded, about the same width as the head. Anterior and posterior margins of pronotum narrowly non-chitinized; sagittal line present, prosternum with two large sclerites in front of the coxæ and contiguous along the median line. Meso- and metathorax the same width as the prothorax but about one-half as long; sclerites of meso- and metanotum fairly large and irregular; the former subtriangular and less irregular than the latter, which are transverse and each with a posterior T-shaped projection. Epi- and hypopleurites both rounded, bearing a seta surmounting a little tubercle. Mesothoracic spiracles each at the tip of a small tubercle. Two small, elongate, præ-mesotergal sclerites present. Sagittal line prominent.

Legs about as long as the thorax is wide; coxæ transverse; femora nearly as long as the tibiæ; tarsi shorter than the latter, claw-like and with two inner setæ, one more proximal and shorter. The anterior coxæ are closer together than the four posterior coxæ, which are about the same distance apart.

Abdomen with eight distinct segments and very slightly narrowed caudally, ninth and tenth segments rudimentary. The first seven tergites similar and separated by a conspicuous intersegmental membrane; each of the former has three transverse folds (scutellar fold indistinct) while the latter has only one. The præscuta bear two, oval, chitinized patches, those on the first segment slightly larger than the others. A transverse row of four tubercles, each bearing a seta, present on the posterior folds of the scuta and each segment with the spiracles on little conical tubercles. Epi- and hypopleurites prominently lobed and intersegmental membranes with a single prominent lateral lobe. Sternites with folds corresponding to those of the tergites. The eighth tergite represents the superior valve of the stigmatic atrium and bears a large chitinous plate, a little broader than long and somewhat semicircular, being rounded in front. The caudal border of the superior valve is slightly chitinized, bears a few setæ, and is indistinctly quadrilobed, the two middle lobes more prominent. Ninth tergite trilobed. The entire structure closely resembles that of *Cymbiodyta*.

FULL-GROWN LARVA.—Length, 15 mm.; width, 2.96 mm. Color brownish above and dirty white or gray below. Tubercles and lobes of body much more pronounced, as well as the small brown setæ covering the integument. Head measures 0.86 mm. along the dorsal line and 1.08–1.2 mm. in width. First segment of antennæ about twice as long as the second. Terminal segment of palpus noticeably shorter than penultimate. Prothorax with several, small, dark markings on the pronotum and slightly widened posteriorly. Meso- and metathorax gradually wider than the prothorax. The stem of the T-shaped projections of the mesonotal sclerites lost. Legs

not as long as thorax is wide. First six segments of the abdomen about the same width as each other and slightly wider than the mesothorax. The scutella are more distinct. Seventh to eighth segments narrowed caudally. Small round patches composed of tapering setæ are present on the folds as follows: six on the anterior scutal fold, the two inner ones almost contiguous; three on the posterior scutal fold; four on the scutellum; and four on the intersegmental membrane. The pleural lobes also bear groups of these setæ in addition to the brown setæ.

### **Hydrobius fuscipes** Linnæus

Plate I, Figures 3 and 8

In the early spring *fuscipes* is very abundant but, as the season progresses, they are harder to locate. Many have been taken under lights at night and they take flight very readily. Thus their apparent absence from their normal habitat is doubtless accounted for. This absence is evidently only periodic, as they are sometimes quite abundant in the middle of July when the pools are becoming concentrated. Miall says that many pupæ of *fuscipes* are found during July and that the globular cell is formed one-half an inch below ground in mud or clay on the bank. He adds that the adults appear in August and soon lay their eggs.

No constant differences could be found between the larva of this species and *globosus*. *H. fuscipes* is often a little smaller but otherwise they are apparently identical. No specimens of full-grown larvæ are at hand, but I would not expect striking differences in them. The middle tooth of the labro-clypeus seems to be constantly truncate in the specimens of *fuscipes* which were examined, but I hesitate to consider this as a separation character.

### **Hydrobius tessellatus** Ziegler

A full-grown larva of this species was taken, together with the adult, by Mr. E. A. Schwarz. It was found among some leaves which had caught in the tree-roots near the bank of a swiftly flowing stream. The larva closely resembles *globosus* and is quite tuberculate.

### **Hydrobius scabrosus** Horn

All the stages, except the egg-case, are in the U. S. National Museum Collection. They were taken September, 1891, in débris in a stream at Bear Creek, Montana. The larva looks very much like a small *globosus* larva. It differs, however, in the teeth of the labro-clypeus. The full-grown specimen has only four distinct teeth, three to the right and a fourth set a little to the left of the three. The middle tooth of the



three, however, shows an indication of another tooth. The mandibles have three inner teeth but the most proximal tooth of each is very small. The cerci of the pupa are tapering, fleshy, and about equal to the seventh to ninth abdominal segments inclusive. The motory styli of the abdominal terga are four in number and each pleurite bears one.

#### HELOCOMBUS Horn

Only one species, *H. bifidus*, represents the genus over the entire world. In the field it is often confused with *Hydrobius fuscipes* and differs principally in its longer maxillary palpus, the last segment of which is shorter than the penultimate. It might be taken for *Philydrus cinctus*, a common associate, but the elytra of the latter is not striate.

Few specimens have been captured in the immediate vicinity of Ithaca and it is only by chance that one collects them. However, they proved to be rather plentiful during May in the pools bordering the Ringwood Road at the source of Cascadilla Creek. Their life is spent under leaves at the edge of the ponds. The life history is unknown but the stages are probably close to *Cymbiodyta*.

#### CYMBIODYTA Bedel

Superficially this genus is very close to *Philydrus* but is easily separated by the transverse mesosternal carina, in contrast with the longitudinal keel of the latter. The presence of only four segments in the middle and hind tarsi bears additional testimony of the validity of this genus. In New York we have four representatives of this group, namely, *C. fimbriata*, *C. blanchardi*, *C. lacustris*, and *C. rotunda*. Of these, the two former have been collected in the vicinity of Ithaca in fairly large numbers, while there is doubt as to the presence of the latter two, although one specimen<sup>1</sup> of *lacustris* (?) was reported in 1909 by Professor J. C. Bradley. The life history of none of the species has been worked out.

Both *C. blanchardi* and *C. fimbriata* are found in the same environment and are often taken together. The easiest method of collecting seems to be taking the débris, including leaves, sticks, and decaying matter which accumulates near the shore-line, and washing the beetles out by placing and shaking the trash in deeper water. The beetles, as with other Hydrophilidæ, rise to the surface and can easily be picked up by the fore finger and placed in the collecting jar. Often they are so

<sup>1</sup>The specimen is not at hand so I was not able to verify its determination as such.

abundant that they may be taken readily from dead leaves, where the cling to the under side, apparently avoiding the sunlight. They have been observed in both still and flowing water but seemed to be most frequent dwellers in the little pools formed by rain-water or springs. One record shows a specimen captured in moss which was under a small fall in a swiftly flowing stream, but this evidently is not its most common habitat.

The best collecting grounds encountered for these two species were located at the base of a steep hill where the rain-water and springs, which trickled down over the surface of a small plateau, had formed small pools. The plateau was composed of a sandy loam and covered with a mat of dead leaves, etc. It was here in the middle and latter part of July 1916, that all stages of *C. blanchardi* and *C. fimbriata* were observed. Miss Ruby B. Hughes reported to me the presence of larvæ, which climbed up her tent-trap,<sup>1</sup> in abundance. The larvæ proved, in due season, to be *C. fimbriata*, as well as *C. blanchardi*, and a thorough examination of the surrounding area disclosed eggs and pupæ in unusual abundance. The larvæ in all stages were found under the leaves and stones; the eggs, in the moss on the bank; and the pupæ, as well as the emerging adults, in the bank.

### ***Cymbiodyta fimbriata* Melsheimer**

#### Plate XII

The arrangement of the eggs laid in the aquaria by members of this genus was rather puzzling at first because of the fact that no case seemed to be completed. The eggs alone were deposited and covered by a loose spinning of silk, such as is found within an egg-case, but with no outer covering, which is characteristic of the family.

On March 24, 1915, *C. fimbriata* was noted ovipositing in the aquarium on the under side of a stone which was lying out of the water. The beetle seemed to be having difficulty and, supposing from its actions that it was drying up, I placed a drop of water in such a position that it would roll on to the eggs. This, however, caused the beetle to leave its position immediately and it failed to return to its interesting occupation. When spinning, the spinnerets are protruded far out and the silk, which seems to be coming from the tips of the organ, is applied somewhat as paint is by a brush. When the drying up began, as noted above, the

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<sup>1</sup>Miss R. B. Hughes was at that time taking a census of the population emerging from damp places by placing a tent-trap and examining the catch at intervals.

silk seemed to become more and more sticky, thereby making it apparently hard work for the beetle to extricate the spinnerets at the end of each application.

Not until several egg-masses were procured in the field was I assured that *C. fimbriata* is in the habit of laying egg-masses without the usual coverings. On April 28, 1915, at McLean, while collecting in leafy pools where *Hydrobius globosus*, *Paracymus subcupreus*, *Ancæna infuscata* and *Cymbiodyta fimbriata* abounded, I turned up a layer of leaves which were moist but not in the water and noted a mass of thirty eggs similar to those laid in my aquaria indoors. When these had hatched they proved to be the eggs of *C. fimbriata*. In none of my observations on egg-laying have I noted an egg-mass laid by a *Cymbiodyta* that had the usual complete covering; which seems to be conclusive evidence that this species does not add the outer protective layer.

*C. fimbriata* laid from fifteen to forty-three eggs, which hatched out in seven to nine days. It was interesting to note that, if eggs were not taken out of aquaria and isolated, they were usually destroyed by the adults, although I did not observe them in the act.

The larvæ are apparently not as cannibalistic as the larger members of the group and appear not to notice their brothers and sisters unless they accidentally bump into each other. However, one specimen was observed devouring a larva of *Philydrus* which was about the same size as itself. The length of life history in this genus is probably about two months. On May 19, 1915, two large larvæ, evidently hatched from the egg-cases found the latter part of March, were observed in the aquarium. About the middle of June they seemed fairly mature but died without pupating.

Although I have not determined the length of the pupal period in either of the two species, it is probably three or four days, as in *Philydrus*. Upon finding the larvæ in all instars on the flats above mentioned, I searched the bank to see if the pupæ of the beetle could not be located. The first day brought little reward except the egg-masses of *C. blanchardi*. However, on the second day, fortune favored me and several feet from the water in slightly moist loam and an inch or less under the moss, a veritable array of pupæ, including more especially those of *C. blanchardi*, *C. fimbriata* (few), *Dasyllidæ* and *Dytiscidæ*, was found. All stages, except the egg stage, were present in the cells and so, by digging carefully and saving the pupal and larval skins, the necessary connecting links in their life history were easily obtained.



The adults of *C. fimbriata* upon emerging are light brown below; the thorax is light brown; their head is darker brown; the second pair of wings are gray; the first pair are white; and the eyes quite dark brown. Until fully colored, about two days, the adults seemed to remain in their cells, as many were noted as being very dark when removed from their underground home.

On April 11, a number of adults of *C. fimbriata* were dug out from the bank of a pool about five or six feet from the shore-line. This tends to show where the beetles spend their winter days.

EGGS.—There seems to be no special arrangement of the eggs except that they are usually placed like logs in a pile and covered sparsely with fine white silk, through which the eggs may be seen.

NEWLY HATCHED LARVA.—Length, 3 mm.; width, 0.4 mm. Whitish. Head and mandibles light yellow; sclerites of thorax and abdomen light brown (mesocerci darker); integument dotted with minute spines, which are more abundant on the top of the folds than in the furrows.

Head square, elevated slightly; fronto-clypeal sutures weakly indicated; frons limited by the frontal sutures, gradually narrowed towards the median line, semi-circular behind; epicranial suture very short, almost absent; gula reduced with its sutures fairly prominent and confluent; two, small, horizontal, elongate, cervical sclerites present.

Labro-clypeus irregularly toothed, possessing usually seven teeth (the most lateral tooth on each side indistinct), some of which tend to be toothed again, and with four short spines, a little longer than the teeth, regularly placed, arising dorsally between the bases of these teeth and projecting forward. The lateral expansions are similar to each other, with anterior margin straight and slightly inclined laterally. Epipharynx spinous.

Ocular areas in groups of six but rather indistinct. They are arranged more or less in a circle. The anterior three have their axes more horizontal and the last, or sixth, area is more remote than the others, which are nearly equidistant from each other.

Antennæ fairly short, not attaining the tips of mandibles but exceeding the distal inner tooth; first segment equal in length and width to the second; second segment not noticeably swollen in the middle and bearing a small colorless, two-segmented, finger-like antennal appendage, the basal segment small, in addition to the sense-cones, and a single, small, slender appendage at the latter's base and at the inner anterior angle; third segment a little longer than the appendage of the second segment, which is three times as long and wide as the former, and bearing at its extremity three long setæ and several sense-cones.

Mandibles nearly symmetrical, fairly prominent and stout, sharply pointed at their tips, and each bearing two inner teeth, the basal one smaller; the left basal tooth seems to be slightly smaller than the right basal tooth; inner surface of anterior piece and anterior tooth serrate; molar area not serrate.

Maxillæ with joint-like palpifer; stipes large, swollen, narrowed slightly towards the apex, longer than the palpifer and palpus together, and its inner surface provided with a row of five stout setæ and several more slender setæ near the externo-distal angle; palpifer small, a little wider than long, bearing a single, stout, inner, lateral seta,

near its base, and an inner rudimentary lobe, possessing apical setæ; first segment of palpus the same length as the rudimentary lobe of the palpifer and a little more than half the second, while the third is not quite as long as the first two together but more slender and more cylindrical; each bears a few slender setæ, the terminal segment possessing a group of sense-cones at its extremity. Articulating maxillary piece well developed.

Labium extending forward almost as far as the tips of the mandibles; submentum very small; mentum somewhat cordiform; palpiger dome-shaped, four-fifths the mentum in length, bearing several prominent setæ dorsally; labial palpus with first segment short, second segment about three times as long and bearing sense-cones at its tip; ligula present and slightly exceeding the first segment of palpus in length.

Prothorax with sides slightly rounded, of same width as head. Anterior third of pronotum non-chitimized, sagittal line present, prosternum with two fairly large sclerites in front of the coxæ. Meso- and metathorax a little narrower and shorter than the prothorax; sclerites of mesonotum and metanotum fairly large, the former subtriangular and the latter elongate; two elongate sclerites are present in the promesotergal conjunctivum; sagittal line prominent. A spiracle on a small tubercle at each antero-lateral angle of the mesothorax.

Legs fairly long, slightly longer than thorax is wide; coxæ transverse, grooved laterally to receive the femora; femora longer than the tibiæ; tarsi well developed, claw-like, about as long as the tibiæ and bearing two inner setæ. The anterior coxæ are closer together than the four posterior coxæ, which are about the same distance apart.

Abdomen with eight prominent segments and very slightly narrowed caudally, ninth and tenth rudimentary. The first seven tergites similar and separated by a conspicuous intersegmental membrane; each of the former has three transverse folds while the latter has only one. The first tergite bears two transverse chitimized patches on its præscutum. Lateral tubercles are not clearly defined but there are apparently two larger ones on the segment and two smaller more pointed ones on the membrane following. The sternites are not chitinous and have folds corresponding to those of the tergites. The eighth tergite represents the superior valve of the stigmatic atrium and bears a large chitinous plate, which is a little broader than long. The caudal border of the superior valve is chitimized, bears a few setæ, and is slightly bilobed.<sup>1</sup> Procercus one-segmented, subconical, with a chitinous plate on the inside and a group of three setæ arising dorsally from tubercles on their apical half. Mesocercus two-segmented and chitinous; the first segment dome-shaped, bearing a central dorsal seta as well as a ventral seta; the second segment very small, papilliform and bearing a terminal seta (0.4 mm. long); between these two segments there are several sense-cones in the membrane. The ventral valve, or ninth tergite, is trilobed posteriorly and the lateral lobes possess chitinous areas from which arise two setæ mounted on tubercles. The acrocerci<sup>2</sup> are evidently attached to the under side of these lobes and each bears a terminal seta. The median lobe is large and somewhat cordiform; its dorsal surface covered, except for a narrow border, with a chitinous plate. Near the caudal margin are four setæ, the outer two of which are in line with each other and a little anterior the median two.

<sup>1</sup>The outer lobes, which are present in many of the Hydrobiinæ, are indistinct here.

<sup>2</sup>A question arises as to whether the acrocerci are the dorsal tubercles and setæ or the ventral. It is difficult to determine; but, from position as described by d'Orchymont, I have considered them as ventral.

**FULL-GROWN LARVA.**—Length, 7–10 mm. ; width, 1.25–1.8 mm. Orange-colored and, when it is not too dirty, has a peppery appearance due to the dark coloration of the integument at the base of the spines which cover the body. A striking transverse row of dark spots is noted in some larvæ on the tops of the abdominal folds. Head, dorsally, is 0.77 mm. long and 0.64–0.9 mm. wide. Spines of labro-clypeus mostly lost and teeth present a scalloped appearance. Anterior inner teeth of mandibles without serration.

**PUPA.**—Length, 7 mm.; width at its thorax, 3.2 mm. Whitish. Head smooth and bears two supraorbital styli on each side. Pronotum smooth, its anterior margin somewhat trilobed and its posterior margin straight, slightly indented just in front of the base of the elytra. The styli are arranged as follows: ten on the rounded lateral and anterior margins, two of which are on the middle lobe; eight on the posterior margin, counting the two corner ones; two on the middle lobe just posterior and slightly lateral of the two anterior styli; and a transverse row of four in the middle, the outer two a little anterior to the inner two. Mesonotum and metanotum with a transverse row of two styli. Inner spur of metatibia fairly prominent. Tarsi not ending in a spine but blunt and tibiæ not spinous on the outer side. Metathoracic pterothecæ visible from above. First abdominal tergite with a transverse row of four styli; second to seventh abdominal tergites, inclusive, with a transverse row of six styli, the outer one on each side arising from tubercles; second to seventh pleurites each with a stylus; eighth tergite semicircular, the rounded posterior margin bearing two styli; ninth segment with a pair of cerci, a little longer than the eighth and ninth segments together (0.72 mm.), extending caudally and very slightly diverging; ninth sternite with prominent acute externo-caudal angles, a pair of appendages arise from between the eighth and ninth sternites and extend caudad on either side of the median line as far as the base of the cerci and closely appressed. Spiracles fairly prominent and slightly raised.

### **Cymbiodyta blanchardi** Horn

The different stages of this species seem to be practically identical with *C. fimbriata* except that they are smaller in size. The larva possesses a pair of small, very indistinct, oval patches on the second to seventh abdominal tergites, which were not present on the larvæ of *C. fimbriata*.

### **HELOCHARES** Mulsant

The only eastern species, *H. maculicollis*, has not been recorded from our fauna and is not to be expected. It is a more southern species and reaches northward along the Mississippi River and its tributaries only as far as Ohio, Illinois, and Missouri. According to Blatchley, 1910, it occurs very rarely in Indiana (Lawrence and Dubois Counties).



Formerly this genus was united with *Philydrus* and it closely approaches it. *Helochares*, however, may be easily distinguished in the field by the punctures of the elytra, which are arranged in rows. In general form, it is more like *Helocombus*, but this genus possesses longer maxillary palpi and its elytra are distinctly striate.

Cussac, 1852, described the immature stages but his work was not very carefully done. The full-grown larva was figured as well as the pupa. The latter, however, was destroyed before the drawing was finished, with the result that the caudal end was not accurately completed. D'Orchymont, 1913, acting on Ganglbauer's suggestion for a more accurate description of the European species, *H. lividus*, gave an excellent description of the larva and supplemented it with figures.

### ***Helochares maculicollis* Mulsant**

#### Plate XIII

I am deeply indebted to Mr. F. E. Wintersteiner for the opportunity of rearing *H. maculicollis*. On April 12, 1916, I received ten living adults which he had forwarded to me from Richmond, Virginia. They were apparently in good condition, although a number of mites were attached to them on the under side. The specimens had been collected at the edge of leaf-filled pools a few days previous to their shipment.

When placed in the rearing jar, they immediately became submerged and remained on the under side of some stones or burrowed down in the mud. Although on sunny warm days they would be seen swimming about the jar, yet most of their time was spent in hiding. Because of this fact, it was difficult to observe whether or not the females carried any cases as they were reported to do.

On June 4 the container was flooded and soon a number of young larvæ were noted floating on the surface and crawling around the edge of the glass. Later in the day two females were seen swimming at the surface of the water, right side up, each with an egg-case slightly protruding caudally.

The egg-case was attached by two strands to the hind femora and not free as Schiödte describes it in *lividus*. The beetles could swim with little incumbrance. Both cases hatched out two days later and forty-six and forty-two larvæ appeared from the respective cases. Other cases were observed during the first week in July and a single case as late as September 24. The latter case hatched on the 29th. The larvæ

very closely resemble those of *Philydrus* and are very voracious. They do not hesitate to devour each other and apparently flourish on *Cypripodopsis* and *Tubifex*.

Little attention has been paid to the growth of the larvæ but on August 31 of the same year several full-grown larvæ were placed in the terrarium. One of these formed a cell and transformed on September 4. The cell was firmly made and was apparently larger than need be, measuring 7.5 mm. long, 7 mm. wide, and 4.5 mm. high.

EGG-CASE.—Nearly semicircular; follows the contour of the abdomen but slightly exceeds it. It measures 2.16 mm. long and is 2.88 mm. wide at the anterior margin. The two strands which attach the case to the inner margin of the posterior femora are short and flared at the point of attachment. All the eggs are pointed inwardly and their contour is visible through the silken case. The silk on the under side of the case is more tightly woven than that on the dorsal side.

NEWLY HATCHED LARVA.—Length, 2.28 mm.; width at the thorax, 0.342 mm. Whitish, except the brownish chitinated areas; integument dotted with minute setæ.

Head quadrangular, slightly elevated; fronto-clypeal suture weakly indicated except at the sides; frons gradually constricted towards the middle, semicircular behind; frontal sutures uniting to form a short epicranial suture; gula reduced, pentagonal, somewhat semicircular behind; gular sutures prominent and confluent for a long distance; two small, horizontal cervical sclerites present.

Labro-clypeus asymmetrical, with six distinct teeth, all equidistant from each other except the two on the left which are set slightly apart from the other four. Six setæ are present, one on each side of each tooth except between the fourth and fifth from the right. Lateral expansions of the epistoma prominent, nearly similar and with obtuse angles, but not exceeding the labro-clypeus. Epipharynx spinous.

Ocular areas in groups of six and indistinct; arranged somewhat in a circle; the front five placed at regular intervals, while the sixth is a little more distant with its axis nearly horizontal.

Antennæ fairly short, not quite attaining the tip of the mandible nor distal end of the stipes; first segment not quite as long as the second segment, slightly constricted; second segment swollen, about the same width as the first and bearing at its disto-external angle a slender, finger-like antennal appendage as well as a spine-like seta; third segment small, less than one-fourth the length of the second but longer than the antennal appendage and possessing two long slender setæ and several shorter ones.

Mandibles stout, nearly symmetrical, their tips sharply pointed and each with two inner teeth, the proximal tooth being smaller than the distal one; the proximal tooth of the left mandible smaller than that of the right; the anterior pieces and inner teeth indistinctly toothed on their inner surfaces. Molar areas smooth and rounded.

Maxillæ with joint-like palpi; stipes stout, swollen, not noticeably narrowed towards the apex, about two-fifths longer than the palpus and palpi together, its inner surface with a row of five stout setæ, and two slender setæ near the externo-distal angle; palpi short, transverse, and bearing an inner rudimentary lobe, possessing two apical setæ; palpus slightly tapering; the first segment shorter than the palpi and less than one-fourth as long as the second palpal segment; the third segment slightly shorter than the second and with distal sense-cones.

Labium not attaining the distal end of the stipes; submentum extremely transverse, short, joint-like; mentum somewhat cordiform, its upper surface with numerous short spines and a seta in each externo-frontal angle; palpiger shorter than submentum and with sides rounded; first segment of palpus short; second segment about three times as long and possessing several slender apical setae; ligula well developed, slender and almost twice the first palpal segment in length.

Prothorax with sides slightly rounded, of the same width as the head; pronotum well chitinized except at anterior and posterior margins; sagittal line present and continuing throughout the thorax; prosternum with two large sclerites in front of the coxae touching along the median line. Meso- and metathorax slightly wider than prothorax but about one-half as short; mesonotum with fairly well-developed sclerites divided in front by a horizontal suture and with four slightly chitinized square areas at its posterior margin. Pro-mesotergal and meso-metatergal conjunctiva with two very narrow sclerites. Sclerites of metanotum very irregular, each with a widely separated posterior projection. Episterna and epipleura are cushion-like lobes.

Legs fairly long, about twice as long as the thorax is wide; coxae transverse, a little longer than the femora; tibiae slightly shorter than the latter but much longer than the well-developed claw-like tarsi, which bear two inner setae set side by side. The anterior coxae a little, the middle more, and the posterior widely separated.

Abdomen with eight distinct segments and very slightly narrowed posteriorly; ninth and tenth segments rudimentary. The first seven tergites similar and separated by a conspicuous intersegmental membrane; each of the former has three transverse folds, while the latter has only two. The first tergite bears two pairs of small, chitinized patches, the anterior very small and usually covered by the metathorax. Episternites and epipleurites similar to the thoracic ones and are cushion-like lobes. Lateral lobes of intersegmental membranes single and not double as in *Philydrus*. The second fold of each of the first seven segments bears a transverse row of four inconspicuous tubercles, the inner pair more prominent with a small chitinous ring at its base. The tubercles each bear a colorless seta. The sternites have folds corresponding to those of the tergites but have no chitinized areas. The eighth tergite represents the superior valve of the stigmatic atrium and bears a large plate which is wider than long. The posterior margin of the latter is nearly straight, its sides are rounded and its anterior margin only slightly emarginate. The posterior margin of the superior valve is four-lobed, each lobe with a seta. The atrium closely resembles that of *Cymbiodyta*.

FULL-GROWN LARVA.—Length, 8 mm.; width at the mesothorax, 1.27 mm. Gray colored or dirty white except chestnut-brown chitinized areas. Head, dorsally, 0.6 mm. long and 0.69 mm. wide. Labro-clypeus is more oblique. The first segment of the antennae has become more elongate and now is longer than the second segment, the antennal lobe is slightly shorter and less prominent. Mandibles are very blunt and have lost their serrations. Mentum with the seta in each externo-frontal angle prominent as well as each medio-lateral one. Prothorax enlarged slightly posteriorly. Body increases in width gradually as far as the second abdominal segment and then decreases.

PUPA.—Length, 5.2 mm.; width at its thorax, 2.16 mm. Whitish. Head smooth and bears two supraorbital styli on each side.

Pronotum smooth, its anterior and posterior margins straight, the latter very slightly emarginate in the middle. The styli are arranged as follows: ten at the lateral and anterior margins, two of which are at the middle of the anterior margins;



eight at the posterior margin, counting the two corner ones; two just posterior and slightly lateral of the two middle styli of the anterior margin; a transverse row of four in the middle, the outer two a little anterior the inner pair; a few other inconspicuous styli are present.

Mesonotum and metanotum with a transverse row of two styli. Inner spur of metatibia not very prominent. All tarsi not ending in a spine but blunt and tibiæ not spinous on the outer side; first to seventh abdominal tergites inclusive with a transverse row of six styli; second to seventh pleurites each with a stylus; eighth tergite semicircular, the posterior rounded margin bearing two styli; ninth segment with a pair of tapering, fleshy cerci, longer than the ninth tergite (0.62 mm.) extending caudally and diverging slightly. Externo-caudal angles of ninth sternite obtuse and not very prominent. A pair of appendages arise from between the eighth and ninth sternites and extend caudally on either side of the median line to the base of the cerci and closely appressed to the ninth segment. Spiracles oval, prominent, second to sixth visible.

#### ***Helochares normatus* LeConte**

Zaitzev, 1908, placed this species under *Chasmogenus* but questions it. The egg-case, as well as the larva, closely resembles *H. maculicollis* and it doubtless belongs under this genus.

#### **PHILYDRUS<sup>1</sup> Solier**

In our fauna there are six members of this group and, although they are apparently close in general structure, yet coloration, size, and form play such an important part in their separation that they are easily determined after one has had a brief introduction to the systematic study of them. The most easily confused member is doubtlessly *P. perplexus*, which may be easily placed as *Cymbiodyta fimbriata* unless the genus is first assured. In size the species range from *P. ochraceus* (the smallest), *P. nebulosus*, *P. perplexus*, *P. hamiltoni*, and *P. cinctus* to *P. consors* (the largest). The first two species named are very abundant near Ithaca while the latter three are comparatively rare, although one mud-pocket yielded about a dozen specimens of *P. consors* in company with a larger number of *Cymbiodyta fimbriata* when the writer was collecting in late June.

The life history of this genus has been studied only in Europe, where Schiödte reared *P. testaceus* Fabr. and figured<sup>2</sup> the stages in his well-known work. The writer has been able to compare this life history with that of some American forms which he has reared.

<sup>1</sup>Zaitzev, in his 'Catalogue des Coléoptères aquatiques familles des Hydrophilidæ' gives *Enochrus* as the valid name, claiming that *Philydrus* is preoccupied, but the author feels convinced that *Philydrus* should stand. *Philydrus* was originally used without the "h."

<sup>2</sup>The figures by Schiödte are not entirely accurate. The labro-clypeus should be oblique and the left mandible was evidently incorrectly drawn.

The common habitat of all the species seems to be in small pools, either at the water's edge in the mud or in the *Spirogyra* farther out. *P. nebulosus* may be taken at almost all times of the year, depending in the winter upon warm spells. October 17 of one year proved to be the most profitable day encountered for the procuring of the adults of this species, when as many as fifty were taken from the roots of the vegetation bordering the shores of Dwyer's Pond.

The eggs, which vary in number and size in the different species, are usually enclosed in an outer covering of silk or cocoon in addition to the usual inner layer and are particularly characterized by the ribbon-like filament, which only the genus *Hydrobius* approaches. The cocoons are found attached to all kinds of objects but usually at the surface of the water, more frequently to blades of grass or *Spirogyra*, with its ribbon stretched out over the surface. They are laid most abundantly during May but are found from April to August in the field. Indoors they are apt to be laid any month in the year. Ten egg-cases were made by a single specimen of *Philydrus nebulosus* during February and some of them were placed below the surface of the water. The time required for hatching is from six to nine days.

The larvæ may be procured during the summer months by strenuously washing the banks of pools where the egg-cases or adults are found. They seem to burrow in the mud near the water's edge, while some repose on the under side of stones as far from the water as it is moist. In their method of walking they resemble very closely the eruciform type, as their motion is rhythmic. The true legs move first, the inconspicuous prolegs next, and finally the end of the abdomen is used. The larval period lasts about two months.

The pupal stage is quite short, taking up three or four days. This stage was observed indoors either in the aquarium where it was formed or else by taking the mature larva and placing it in a jar with moist earth, where it formed a cell below the surface in the usual manner or pupated on top of the ground. On July 20, 1916, many pupæ of *P. nebulosus* and *P. perplexus* were found in cells underneath stones or in the moist bank. The pools at this time of the year were gradually drying up and naturally possessed a concentrated array of beetles.

The progress of coloring in the adult, after emergence, was observed in *P. nebulosus*. At first the head, thorax, and elytra are very dirty white, nearly brown, and the appendages of the head nearly white, while the legs are tinged a little with brown. The eyes soon get black and the whole body darkens gradually, the thorax getting its color much more slowly than the elytra.

**Philydrus perplexus** LeConte

Plate XIV, Figures 1 to 10

EGG-CASE, without its ribbon, shaped very much like the terminal joint of one's finger. The top of the case is slightly concave, while the under side conforms with the object to which it is fastened. The case proper is 1.8 mm. high and 1.56 mm. across the top, where the greatest width is found. The filament is broader than the diameter of the cap and, although varying in the different cases, is usually about 3.6 mm. in length. The round cap, covering the top of the egg-case proper, is continuous with the inner layer of the ribbon.

NEWLY HATCHED LARVA.—Length, 2.52 mm.; width, 0.39 mm. Whitish, except brownish chitinated portions; integument dotted with minute setæ.

Head quadrangular, elevated slightly; fronto-clypeal suture weakly indicated, more prominent at the sides; frons somewhat campanulate; epicranial suture very short; gula reduced and pentagonal, the antero-lateral sides about one-third the postero-lateral in length; gular sutures prominent and confluent; two small, horizontal, elongate cervical sclerites present.

Labro-clypeus possesses at the extreme right a prominent acute tooth and a row of five to six setæ; the tooth on the right seems to vary quite a little, in some cases being apparently single, in others double and in some tending to be tridentate. Just below there appears to be a flap which is irregularly serrate, and has a fairly prominent tooth<sup>1</sup> at the extreme left. Lateral expansions of epistoma prominent, unequal, acute and slightly exceeding the labro-clypeus. Epipharynx spinous.

Ocular areas in groups of six and indistinct; arranged somewhat in a circle; the first five placed at regular intervals while the sixth is a little more distant with its axis nearly horizontal.

Antennæ fairly short, not attaining the mandibles but exceeding the distal inner tooth; first segment equal to the second in width and nearly the same length; second segment not noticeably swollen in the middle and bearing a small, colorless, finger-like antennal appendage, in addition to the sense-cones at the latter's base; third segment nearly twice as long as the appendage of the second segment, which is three times as long and wide as the former, and bearing at its extremity several sense-cones and long setæ.

Mandibles asymmetrical, fairly prominent, sharply pointed at their tips and with the inner surface of the anterior piece slightly serrate; the left mandible with a single anterior tooth while the right one possesses two; both of the anterior teeth serrate on their inner surface, those of the left often very indistinct; molar areas smooth.

Maxillæ with joint-like palpifer; stipes large, swollen, not noticeably narrowed toward the apex, longer than the palpifer and palpus together, its inner surface provided with a row of five stout setæ, and several slender setæ near the externo-distal angle; palpifer small, the length five-eighths the width, bearing a single stout, inner, lateral seta near its base and a rudimentary lobe possessing apical setæ; palpus borne by the palpifer, three-segmented; its first segment equal to the rudimentary lobe of the palpifer in length and a little more than one-half the second, while the third is not

<sup>1</sup>This tooth may be a part of the labrum proper but in most specimens seems to be in line with the serrate flap.



quite as long as the first two together but slightly more slender and tapering; each bears a few slender setæ, the terminal segment being highly sensory and provided with a group of sense-cones at its extremity. Articulating maxillary piece well developed.

Labium just exceeding the palpifer of the maxillæ; submentum small; mentum somewhat cordiform; palpiger dome-shaped, two-thirds the mentum in length, bearing a longitudinal row of three dorsal setæ on each side of the median line; labial palpus with first segment short, second segment less than three times as long and bearing sense-cones at its tip and a number of setæ at its base; ligula present and a little longer than the first segment of the palpus.

Prothorax with sides slightly rounded, of the same width as the head; anterior and posterior of pronotum non-chitinized; sagittal line present; prosternum with two fairly large sclerites in front of the coxæ touching along the median line; meso- and metathorax shorter than the prothorax, and the metathorax narrower than either thoracic segment; sclerites of mesonotum and metanotum fairly large, the former crescent-shaped as a whole, and the latter irregular; two inconspicuous, narrow sclerites are present in the pro-mesotergal conjunctivum; sagittal line prominent. Mesothoracic spiracles mounted on a small tubercle in each antero-lateral angle.

Legs fairly long, a little longer than the thorax is wide; coxæ transverse, grooved laterally to receive the femora; femora a little longer than the tibiæ; tarsi well developed, claw-like, about as long as the latter and bearing two inner setæ; the two anterior coxæ are closer together than the four posterior coxæ, which are about the same distance apart.

Abdomen with eight segments distinct and very slightly narrowed caudally, ninth and tenth segments rudimentary. The first seven tergites similar and separated by a conspicuous intersegmental membrane; each of the former has three transverse folds while the latter has only two. The first tergite bears a pair of subrectangular chitinized patches on its præscutum, while there is a pair of small oval, chitinized patches on the præscuta of the next six segments. Lateral tubercles are not clearly defined but there is apparently one large one on the segment and two smaller more pointed ones on the membrane following. On the second fold of each of the seven segments, a transverse row of four tubercles, each bearing a seta, may be seen. A pair of very inconspicuous spiracles present on each of the first seven segments. The sternites are not chitinous and have folds corresponding with those of the tergites. The third to the seventh each possess a pair of prominent tubercles which resemble prolegs and are furnished with a group of recurved spines on their ventral surface. The eighth tergite represents the superior valve of the stigmatic atrium. As the larvæ of this genus belong to the same type of pseudo-metapneustic larvæ as *Cymbiodyta*, a redescription of the atrium seems unnecessary.

FULL-GROWN LARVA.—Length, 6–8 mm.; width at the mesothorax, 1.80 mm. Gray or dirty white and, when not too dirty, somewhat peppery, but not so noticeably as in *Cymbiodyta*. A transverse row of dark spots is noted on the tops of the abdominal folds in some larvæ, especially those which have just molted.

Head, dorsally, 0.768 mm. wide and 0.624 mm. long. Serrate flap of labrum mostly lost, except tooth at right, and frontal angles blunt. Appendage of second segment of antennæ much smaller in comparison with the third segment. Serrations of the anterior teeth of the mandibles lost and those of the inner surface of the anterior piece very indistinct or lost. The first segment of maxillary palpus about one-half the second. A row of four stout dorso-lateral setæ on each side of the mentum and a

strong dorsal seta on either side of the median line, slightly anterior in position; the seta at the base of the labial palpus stout and fairly prominent and those at the base of the second segment slender.

PUPA.—Length, 5.13 mm.; width at its thorax, 2.22 mm. Entirely whitish, except eyes. Head smooth and bears two supraorbital styli on each side, the anterior styli more lateral than in *Cymbiodyta*, in which they are set nearer the median line than the posterior styli; an inconspicuous tubercle on each side of the median line near the vertical margin.

Pronotum smooth, its anterior margin somewhat trilobed and its posterior margin straight, slightly indented just in front of the base of the elytra. The styli are arranged as follows: ten on the lateral and anterior margins, two of which are on the middle lobe; eight on the posterior margin counting the two corner ones; two on the middle lobe just posterior and slightly lateral of the two anterior styli (these four styli are more in a transverse line than in *Cymbiodyta*) and a transverse row of four in the middle, the outer two a very little anterior the inner pairs. Mesonotum and metanotum with a transverse row of two styli. Inner spur of metatibia fairly prominent, an outer adjacent spur less prominent. Tarsi not ending in a spine but blunt and tibiæ not noticeably spinous on the outer side, although the meso- and metatibiæ have slight indications of spines. First abdominal tergite with a transverse row of four styli; second to seventh tergites inclusive, with a transverse row of six styli, the outer one on each side arising from a tubercle; second to seventh pleurites with a stylus; eighth tergite semicircular, the rounded posterior margin bearing two styli; ninth segment with a pair of tapering, fleshy cerci, a little longer than the sixth to ninth tergites together (1.2 mm.), extending caudad and very slightly diverging. Ninth sternite with prominent, acute, externo-caudal angles. A pair of appendages arise from between the eighth and ninth sternites and extend caudad on either side of the median line to the base of the cerci and closely appressed to the ninth segment.

### *Philydrus nebulosus* Say

#### Plate I, Figure 9

This species is very close to *P. perplexus* in its early stages and the egg-cases have no distinctive characteristics for their separation. From thirteen egg-cases, an average of 19 larvæ were obtained with 24 and 11 as the extremes. Eggs, laid on March 16, hatched on the 25th. They seemed to feed readily on the entomostracans, Chironomidæ, *Tubifex*, etc., in the aquarium, and the first molt was noted in eight days. I failed to see the second molt but on June 3 pupæ were observed on *Cladophora*, which had pushed just above the surface of the water. The newly hatched larvæ measured 2.256 mm. in length by 0.312 mm. The inner surfaces of the anterior pieces and anterior teeth of the mandibles and flap of labrum much more prominently toothed than in *perplexus*. These latter serrations seem to keep prominent in the more mature larvæ, although most of the fully grown larvæ are hardly distinguishable from *P. perplexus*.

The pupa is identical with that of *perplexus*, except that it is generally smaller. Length, 4.5 mm.; width, 1.6 mm.

### ***Philydrus ochraceus* Melsheimer**

Plate XIV, Figure 11

As this is our smallest *Philydrus*, the stages are smaller throughout. The egg-case, which is characteristic of this genus, is much more flattened than in the other species and the ribbon seems to be correspondingly broader. The length of the case proper is 1.32 mm., its width about the same, while the filament is twice as long, or 2.65 mm., in the specimens at hand. An average of twelve eggs hatched from each case.

NEWLY HATCHED LARVA.—Length, 1.97 mm.; width 0.288. mm. Chitinized parts light yellow; and reddish eyes are distinct. Inner surface of the anterior piece of each mandible distinctly serrate; the right anterior tooth dentate but the left anterior tooth and the right posterior tooth simple.

### ***Philydrus cinctus* Say**

Although I question whether it is the customary habit of this species to omit the usual outer covering, yet such was the condition found in one of the indoor aquaria. On June 4, 1915, a female laid a mass of thirty eggs, perpendicular to a stone under some *Cladophora* and with only the loose inner spinning of silk to cover it. Unfortunately, the eggs did not hatch. The full-grown larva, measuring 7.9 mm., was, however, captured. It had no serrations on the mandibles and the labro-clypeus possessed a single tooth at the extreme right and left. Serrate flap with four inconspicuous teeth. Pupation occurred on July 20 and the adult emerging on the 23rd was entirely light brown.

### ***Philydrus hamiltoni* Horn**

An adult female taken on May 11, 1916, deposited an egg-case on a moneywort leaf in the aquarium the 15th, and thirty larvæ hatched out on May 20 and 21. On the same day that the adult was collected, an egg-case was taken in Vanishing Brook, where it was attached to a blade of grass at the edge of the water. The egg-case proper is 3.4 mm. wide at the middle and 2.3 mm. high. The filament, which spread out over the surface of the leaf, measured 2.3 mm. in width and 6.8 mm. in length. It is of about the same breadth throughout and in this respect is more like *ochraceus* than *nebulosus* or *perplexus*.



NEWLY HATCHED LARVA.—Length, 2.66 mm.; width, 0.39 mm. Chitinated parts mostly brownish; the anterior of the head, however, except the palpus of the maxilla, light yellowish. Inner surface of the anterior piece of each mandible serrate. The right distal inner tooth serrate but the distal left and the right proximal inner teeth are simple. The serrate flap of the labrum is fairly conspicuous and with a very prominent tooth at the left.

**ANCÆNA** Thomson (*ex parte* *Cryniphilus*<sup>1</sup>)

There is hardly a stream or pool in the vicinity of Ithaca that will not yield the only representative of this genus which frequents our waters, *Ancæna infuscata*. The specific name is well applied but close examination is necessary to be absolutely positive that it is not the closely related *Paracymus subcupreus*. The most ready character for their separation lies in the nature of the hind femur which in *infuscata* is densely punctulate and pubescent, except near the tip; while in *subcupreus* it is smooth, finely strigose, and not pubescent but with a few scattered punctures.

Although very often taken together, yet some collecting grounds will show one or the other of these species to be in predominance, *A. infuscata* being the more numerous as a rule. The adults are particularly abundant during certain seasons. The spring season collecting brings the richest harvest and hundreds of them may be taken in single clumps of grass, the roots of which are submerged in the waters of little pools or streams during the week following the spring flood. They rarely seek the sunlight, at least in cool or cloudy weather, but hide beneath the blades of grass, leaves, or debris at the shore-line. One day, however, a group of them was noted dotting the upper surface of some submerged stones; they were apparently basking in the sunlight and very much resembled small scale insects. When searching for their place of hibernation, several were taken in April a few feet from the water under stones and pebbles.

D'Orchymont described the larva of *Ancæna limbata*. This species closely resembles *Paracymus subcupreus* but differs considerably from *A. infuscata*.

**Ancæna infuscata** Motschulsky

Plate XV

The egg-cases are similar to those formed by *Laccobius*, from which they are separated with difficulty. My notes for the season of egg-laying give only the month of May. The number of eggs, enclosed in the case,

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<sup>1</sup>This is the original spelling of the genus. Later authors incorrectly used *Cryniphilus*.

varied from five to eight, and ten days were required for eggs laid in the aquaria on May 12 to hatch. It is possible to obtain larvæ during nearly the whole year, if the aquarium is well stocked with adults. Records show them to be present from April to October, inclusive, besides during February. A number of fairly well-grown larvæ were found under a stick in a moist situation on May 28. As pupæ were observed during the middle of July, the larval period is probably of about two months' duration.

EGG-CASES.—Case, without its filament, nearly round and varies in size, as does the filament. The case proper averages 1.13 mm. in width and 1.08 mm. in length; and the filament, 0.44 mm. in width at its base and 3.47 mm. in length. The top of the egg-case tends to be slightly flat and the cap is continuous with the filament, forming a slight cavity at the base of the filament, which tapers slightly towards its tip and is flat and ribbon-like.

NEWLY HATCHED LARVA.—Length, 1.67–1.93 mm.; width, 0.296 mm. Whitish, except chitinized portions which are yellowish; integument, including thoracic sclerites, dotted with minute setæ which arise from microscopic tubercles.

Head quadrangular, very slightly elevated; fronto-clypeal suture weakly indicated, more prominent at the sides; frons somewhat campanulate, its rounded posterior end attaining the caudal margin of the head so that there is no epicranial suture and the postfronto-vertical sclerites do not meet; gula pentagonal, and the gular sutures prominent and confluent; two small, horizontal, elongate, cervical sclerites present.

Labro-clypeus with its anterior margin nearly in line with the lateral expansions of the epistoma, quadridentate and possessing a row of four setæ. Left expansion slightly more prominent than the right, both rounded and bearing a few short setæ. Epipharynx spinous.

Ocular areas in groups of six and indistinct, arranged somewhat in a circle; the first three equidistant and with their axes nearly vertical, while the other three have their axes nearly horizontal.

Antennæ fairly short, barely exceeding the distal inner tooth of the mandible; first segment nearly equal to the second in width, a little longer and slightly constricted; second segment swollen somewhat in the middle and bearing a colorless, finger-like appendage, in addition to the sense-cones at the latter's base; third segment the same length as the appendage of the second segment, about twice as wide and long as the second segment, and bearing at its extremity several sense-cones and several long setæ.

Mandibles symmetrical, fairly prominent, sharply pointed at their tips and with three strong inner teeth, the anterior two about the same size and larger than the small basal tooth; molar areas smooth.

Maxillæ with joint-like palpifer; stipes large, swollen, slightly narrowed towards the apex, longer than the palpifer and palpus together, its inner surface provided with a row of five stout setæ, and two lateral slender setæ on its distal half, one placed behind the other; palpifer fairly large, about the same width as its palpus, nearly as wide as long, bearing a single, stout, inner, lateral seta near its base and a rudimentary lobe, possessing apical setæ; first segment of palpus about the same length as the rudimentary lobe of the palpifer and equal to the second in length and width, while

the third segment is about as long as the first two together and nearly as wide; each bears a few slender setæ, the terminal segment with a group of sense-cones at its extremity.

Labium slightly exceeding the inner distal tooth of the mandible; submentum small; mentum and palpiger cylindrical and about the same size; mentum with short, stout setæ mounted on tubercles; palpiger with a longitudinal row of three distal setæ on each side of the median line and an additional pair just inside the middle pair of the latter row; palpus with first segment short, second segment about three times as long and bearing sense-cones and setæ at its tip as well as at its base; ligula present and nearly as long as the second segment of the palpus.

Prothorax with sides slightly rounded, a little wider than the head; anterior margin of pronotum fringed with a row of minute setæ set close together; epicranial suture present; prosternum with two fairly large sclerites in front of the coxæ touching along the median line but not highly chitinized; meso- and metathorax shorter than the prothorax and about the same size as each other; the two sclerites of the mesonotum large, with the anterior margin of the whole concave; two triangular sclerites present in the pro-mesotergal suture; the spiracles on tubercles at the externo-frontal angles of the mesothorax; metanotum with two pairs of elongate sclerites; the caudal pair smaller and each with a prominent seta on its inner half.

Legs short, a little longer than one-half the width of the thorax but with just the distal end of the tibiæ and tarsi showing from above; coxæ transverse; femora a little longer than the tibiæ; tarsi claw-like, shorter than the latter, bearing a prominent inner seta, and another less prominent one towards the base; the two anterior coxæ are closer together than the four posterior coxæ, which are about the same distance apart.

Abdomen with eight distinct segments only slightly narrowed caudally, ninth and tenth segments forming the atrium. The first seven tergites similar and each with two transverse folds while the intersegmental membrane has only one. The præscutum of each of the first seven tergites bears a pair of small, oval, chitinized patches, the first pair being more prominent and elongate than the other six. A prominent lateral tubercle present on both the segment and the membrane, the one on the former being larger and more rounded than that on the latter. Below the lateral tubercle of the segment there are two others. The tubercles on the folds are hard to make out but are arranged in transverse rows as follows: six on the first fold of the segment, the middle pair united by a small narrow fold; eight on the second fold; and six on the intersegmental membrane, the middle pair united by a small narrow fold. The pair of tubercles on each side of the middle pair of tubercles of the second fold bear a seta. Each spiracle situated between the outer pair of tubercles of these first two folds. The eighth tergite represents the superior valve of the stigmatic atrium. The structure of the atrium is similar to that of *Laccobius*. The caudal border of the superior valve is nearly straight, slightly rounded in the middle. The procerci and especially the mesocerci are quite prominent; the lateral seta of each is slender but strong and slightly wavy.

FULL-GROWN LARVA.—Length, 3.76 mm. (5.11 mm. extended); width at the fourth abdominal segment, 1.21 mm.; depressed. Light yellowish; head and thorax darker than the abdomen with the exception of the abdominal tubercles, which are brownish and more pronounced than in the first instar. The tubercle on each side of the middle pair of tubercles on the second fold of each segment is the most prominent



of all the tubercles and together they form two longitudinal rows, especially distinct in freshly molted larvæ. The three pairs of lateral tubercles on each segment are very prominent. The sternites possess three folds and the ventral side of the intersegmental membrane one. The setæ on the anterior margin of the pronotum are sparser, about fifteen on each side of the median line, but longer, more prominent. Legs not visible from above. Dorsal plate of eighth segment slightly lobed medially at its caudal margin. Head, dorsally, 0.35 mm. long and 0.43 mm. wide; retractile as far as the ocular areas. Ligula longer than the second segment of the palpus. A transverse row of ten stout, dorsal setæ noted on the mentum nearly through the middle and directed forward; the inner two setæ seem to be on the epipharynx, which bears short and stout setæ.

#### **PARACYMUS** Thomson (*ex parte Cryniphilus*)

As suggested under *Ancæna*, this genus is very closely allied to that one. They were formerly united under *Cryniphilus*. The ready characters which distinguish the single local species, *subcupreus*, from *Ancæna infuscata* have been given under that genus. Zambou found the pupa of *Paracymus æneus* beneath a stone near water but his description was very superficial. This is the only observation made upon the life history of the genus, with the possible exception of the description of *Ancæna limbata*, which may in reality belong to *Paracymus*.

#### **Paracymus subcupreus** Say

##### Plate XVI

The eggs are not enclosed in a case but only covered with scattered threads of silk. Most of the egg-laying occurs in May but one egg-mass was obtained indoors on April 20. The number deposited varied from ten to fifteen, and the eggs usually hatched in about seven days.

Two pupæ were taken on July 19 from cells which were formed less than an inch below the surface of the ground and two feet from the edge of the water. The length of the pupal period was four days, as shown by a larva which was reared in the aquarium. It transformed on September 12 at noon and emerged on the afternoon of the 16th. Another pupa, collected on August 11 from a cell underneath a stone, came out on the 13th.

The adult, upon emergence, was colored as follows: head brown, with eyes darker; tips of the maxillary palpi almost black; antennal clubs white; thorax and scutellum brown but lighter than the head; legs light brown; elytra white except light brown margins along the median line; under side of abdomen white.

EGG-CASE.—Eggs are covered only with loosely applied silk and each measures 0.54 mm. in length and 0.027 mm. in width.

NEWLY HATCHED LARVA.—Length, 1.13 mm.; width, 0.288 mm. Whitish, except chitinated portions which are brownish; integument, including thoracic sclerites, dotted with minute setæ.

Head quadrangular, very slightly elevated; fronto-clypeal suture weakly indicated, more prominent at the sides; frontal sutures converging strongly caudally as far as the middle of the head, then slightly diverging to the posterior margin of the head; and united by a transverse suture which runs along the hind margin of the head so close that it is hardly noticeable; epicranial suture absent and the postfronto-vertical-sclerites widely separated; gula reduced, pentagonal, with its sides concave, especially the latero-anterior ones; the anterior angles acute; gula sutures prominent and confluent; two, small, oval, cervical sclerites present.

Labro-clypeus tridentate, the outer two teeth bifid, with a row of four setæ, each of which is located between the five teeth. Left frontal angle slightly less prominent and less advanced than the right, which is nearly in line with the anterior margin of the labro-clypeus. Both angles rounded and bearing a few short setæ. Epipharynx spinous.

Ocular areas roundish; in groups of six and indistinct; arranged somewhat in a circle.

Antennæ fairly short, barely exceeding the distal inner tooth of the mandible; first segment a little wider and longer than the second and slightly indented on the inner side; second segment swollen and bearing a colorless, finger-like appendage, in addition to the sense-cones at the latter's base; third segment about the same length as the appendage of the second segment, two-thirds as long and half as wide as the second segment, and bearing several sense-cones and a prominent terminal seta.

Mandibles symmetrical, prominent, sharply pointed at their tips and with two strong inner teeth; serrations on the inner surface of the tip as well as on the inner surfaces of the inner two teeth but indistinct, those on the left mandible more prominent; molar areas smooth.

Maxillæ with joint-like palpifer; stipes large, swollen, very slightly narrowed towards the apex, much shorter than the palpifer and palpus together, with a stout inner disto-lateral seta (there may be a row but it was not observed) and a number of small, stout dorsal setæ mounted on tubercles; palpifer large, a little wider than long, bearing a single, stout, inner lateral seta near its base and a rudimentary lobe, possessing several short, apical setæ, besides a single longer seta; palpus slightly narrowed towards the apex, all segments about the same length; first segment nearly three times the length of the rudimentary lobe of the palpifer; the terminal segment with a group of sense-cones at its extremity; articulating maxillary piece well developed.

Labium slightly exceeding the distal inner tooth of the mandible; submentum very small; mentum subcordiform, narrower and shorter than the palpifer, which is broadened distally and bears a seta on each side of the median line near the anterior margin; palpus with second segment more slender, one and a half times as long as the first segment and possessing sense-cones at its extremity; ligula nearly as long as the palpus, apparently two-segmented, the first segment nearly as long as the first segment of the palpus

Prothorax with angles rounded, slightly wider than the head; pronotum well developed, entirely chitinized, two tubercles on each side of its caudal half, two setæ on each side just inside of the lateral half of the anterior margin; sagittal line present; prosternum chitinized in front of the coxæ. Meso- and metathorax shorter but slightly wider than the prothorax and about the same size as each other; mesonotum with two large, quadrangular sclerites almost as wide as the segment but not attaining the sides; a lateral tubercle on each side and a spiracle on the tip of a minute tubercle in front of each; metanotum with a pair of narrow, elongate sclerites on its anterior half; the posterior half with two areas, corresponding in position to the sclerites on the anterior half, chitinized and with two tubercles arising from each; a lateral tubercle bearing a short, colorless seta present on each side.

Legs short, not visible from above, about as long as half the width of the thorax; coxæ transverse and grooved to receive the femora; femora a little longer than wide; tibiæ about as wide as long and shorter than the femora; tarsi claw-like, inconspicuous, shorter than the latter, and bearing a single inner seta; the two anterior coxæ are closer together than the four posterior coxæ which are about the same distance apart.

Abdomen with eight distinct segments, the first three slightly widened, the next five narrowed very slightly caudally and the ninth and tenth forming the atrium. First seven tergites similar and each with three transverse folds, clearly defined only in the middle; intersegmental membranes with a single fold; each præscutum bears a pair of oval chitinized patches. The tubercles on the folds are arranged as follows: one each side of the first and third folds about half-way between the median line and the side of the segment; two tubercles on each side half-way between the former tubercles and the lateral tubercle of the segment; one placed nearly behind the other (the anterior one bears the spiracle); two on the second fold, each arising from an elongate chitinized area on each side of the median line; a dorsal tubercle on each side of the intersegmental membrane. The middle region of the membranes has a narrow, elongate, chitinized area. Spiracles on small tubercles. There are apparently three longitudinal rows of lateral tubercles, the dorsal two being the most prominent. The eighth tergite represents the superior valve of stigmatic atrium. The caudal margin nearly straight but indistinctly lobed. The mesocerci prominent and broadly dome-shaped.

FULL-GROWN LARVA.—Length, 4.57 mm. (extended); width, 1.02 mm. at the third abdominal segment; not depressed. Yellowish except tubercles, which are brownish and much more pronounced than in the first instar.

Head, dorsally, 0.4 mm. wide and 0.35 mm. wide; retractile. Epipharynx with spinous surface prominent. Antennal segments more elongate. Labro-clypeus with the teeth prolonged forward more distinctly, tridentate; lateral tubercles prominent and subconical. There are three transverse folds on each abdominal sternite and one on the ventral side of the intersegmental fold.

PUPA.—Length, 2.42 mm.; width at its thorax, 1.345 mm. Entirely whitish, except the eyes. Head smooth and bears two supraorbital styli. Pronotum smooth, its anterior margin somewhat trilobed and its posterior margin straight. The styli are arranged as follows: ten near the anterior margin, four<sup>1</sup> of which are on the middle lobe; ten<sup>2</sup> near the posterior margin counting the two corner ones; a transverse row

<sup>1</sup>The outer two of these are more anterior in position than in *Cymbiodyta* or *Philydrus*.

<sup>2</sup>Medio-lateral setæ are more posterior so that they may be considered in the posterior row.



of four just a little anterior of the middle, with the outer two set a little more forward than the inner two. Metathoracic pterothecæ visible from above. Mesonotum and metanotum smooth, with a transverse row of two styli, each just lateral of the scutellum. Inner spur of metatibia not very prominent and blunt, no outer adjacent spur present. Tarsi not ending in a spine but blunt and tibiæ not noticeably spinous on the outer side, although all tibiæ have slight protuberances. First to seventh abdominal tergites with a transverse row of six styli, the outer one on each side arising from a tubercle; second to seventh pleurites each with a stylus; eighth tergite semi-circular, the rounded posterior margin bearing two styli; ninth segment with a pair of tapering, fleshy cerci, about as long as the ninth tergite (0.215 mm.), extending caudally and slightly diverging. Externo-caudal angles of ninth sternite not prominent and acute. A pair of appendages arise from between the eighth and ninth sternites and extend caudally on either side of the median line to the base of the cerci and closely appressed to the ninth segment. Spiracles well defined but small.

### 9. *Sphæridiinae*<sup>1</sup>

Eggs laid in a mass with a slight covering of loosely applied silk or a round blanket-like covering of closely applied silk (*Phænonotum*); deposited in dung, damp earth, or on damp leaves. Larva with head elevated; antennæ with their points of insertion situated farther from the externo-frontal angles of the head than those of the mandibles; epicranial suture absent; ocular areas flat, round, small, varying in size (first to third larger than fourth to sixth in *Phænonotum* and *Cælostoma*) and closely aggregated; labrum and clypeus reduced and united; with a small projection usually unidentate but tridentate in *Phænonotum*; antennæ with a more or less prominent antennal appendage; mandibles sharply pointed distally, strongly curved and with inner teeth, or without inner teeth and grooved on the inner side (*Sphæridium*); stipes widened and depressed on the outer side in *Sphæridium* and *Cercyon* but normal in *Phænonotum* and *Cælostoma*; stipes with many small setæ on its inner and outer sides; second segment of labial palpus distinctly longer than the first; labium and maxillæ inserted at the anterior margin of the under side of the head; the ventral side of the head in *Sphæridium* and *Cercyon* with the median line impressed and with a small pit in the middle; gula very much reduced and not attaining the occipital opening; jugular sclerites (in front of procoxæ) well developed; tarsi present (*Cælostoma*, *Phænonotum*), tarsi absent (*Sphæridium*), or legs entirely wanting (*Cercyon*). Eight complete abdominal segments; ninth and tenth reduced, forming a stigmatic atrium. Spiracles are rudimentary and bifore. Type of breathing is pseudo-metapneustic. Cerci reduced, two-segmented. The abdomen bears no chitinated plates and is more or less truncate. The larvæ show a tendency towards the scarabæoid type.

### III. PHYLOGENETIC CONSIDERATIONS

Among the Hydrophilidæ there has been an evolution of distinct generic types. This is particularly evident among the larvæ and, in an endeavor to show the general trend of adaptation, a phylogenetic tree

<sup>1</sup>This subfamily requires very much additional study but the characters thus far known and those taken from additional material at hand have been incorporated. The larvæ of *Phænonotum* and *Cælostoma* differ materially from those of *Sphæridium* and *Cercyon*.

(page 81), based entirely upon larval characters, has been erected. Just what value the larval characters have for purposes of classification is a question. As a rule, the larvæ and adults of this family appear to have evolved hand in hand but, in some cases, it is evident that one specialized while the other tended to remain primitive. Nevertheless, some value must be attached to these larval characters.

Many controversies have arisen over the question of what determines a primitive larva. Brauer, 1869, established the well-known law: "Je näher Larve und Imago einander und der form der Stammkerfe stehen, oder je weniger die imago, die Larve and vollkommener Organisation übertrifft, desto älter ist die Form." The essential thought of this law has stood ever since but qualifications have been necessary. Peyerimhoff, 1900, in discussing this law, stated that a careful examination of all parts is necessary to prove that a larva, apparently campodeiform, is absolutely primitive.

Lameere, 1899, believed that holometabolism was brought about by the boring of insects in vegetable tissues. As a result, an eruciform type of larva was evolved. In 1903, he said that Brauer's law could only be accepted for insects without metamorphosis and that supposed campodeiform larvæ of holometabolic insects are only campodeiform in appearance, being the result of ethological convergence. They are derived from eruciform larvæ adapted to feeding on vegetation. The larvæ of the primordial holometabolic insects thus acquire these special characters only through the influence of similar habits.

It was the belief of Gangldauer, 1904, that the Hydrophilidæ constitute a terminal family of a primitive branch of Coleoptera whose stock has been lost. The natural place, he said, is between the Staphylinidæ, with which they agree in the presence of larval cerci, and the Diversicornia, with which they agree in venation. He thus indicated that the Diversicornia, which he had established in 1902, was not monophyletic; and, at the same time, he indirectly accepted Lameere's grouping of the Hydrophilidæ under the suborder Palpicornia. This is apparently the most logical place for the family.

In this paper the true campodeiform larva has been considered as the most primitive type. By true campodeiform larva is meant that type of campodeiform larva which has not been evolved by ethological convergence, but one which is strictly primitive. One finds but little difference between *Limnebius*, *Hydræna*, etc., and the primitive type. A careful examination of the specific parts in these genera reveals only such characters as are fundamentally primitive. Apparent vestiges of

the maxillulæ, which Carpenter noted in the Diversicornia, are to be found at the sides of the hypopharynx in these forms and bear further testimony to their primitive position.

The following larval characters are considered primitive.

1. True campodeiform type of body.
2. Well chitinized integument.
3. Head inclined.
4. Ocular areas in groups of five.
5. Antennæ three-segmented and with their points of insertion nearer the externo-frontal angles than those of the mandibles.
6. Labrum and clypeus distinct and well developed.
7. Mandibles with a *lacinia mobilis*.
8. Maxilla with a well-developed inner lobe.
9. Presence of rudimentary maxillulæ.
10. Labium short with complex ligula and palpi.
11. Gula well developed and attaining the occipital opening.
12. Labium and maxillæ inserted in a furrow on the under side of the head.
13. Legs well developed; tarsi without claws but claw-like.
14. Holopneustic type with annuliform spiracles.
15. Cerci three-segmented.
16. Ten abdominal segments.

The number of eggs deposited and the manner in which they are protected are both important in phylogeny. The eggs of the most primitive genera are laid singly and without a silken covering or, at the most, with only a slight covering. On the other hand, many eggs are deposited in a mass and enclosed in a complex case by the members of those genera best adapted to aquatic life.

The pupæ of the most primitive genera have not been described. The genera best adapted to water show a reduction in the number of pronotal styli and an increase in the distinctness of the annulations of these styli. The cerci become stouter and more complex, as shown by the possession of spines, more distinct annulations, and bifid shape.

The most striking character of phylogenetic importance which appears among the adults is, without doubt, the number of abdominal sternites. Those genera possessing six or more sternites have larvæ which show a small indication, at least, of their evolution from the primitive type. *Berosus* and *Laccobius* still possess a vestige<sup>1</sup> of a furrow on the under side of the head. All other Hydrophilidæ have five abdominal sternites<sup>2</sup>. Neither the antennæ nor the tarsi are apparently stable adult characters and the venation requires further study.

<sup>1</sup>This evidently represents the former insertion of the labium and maxillæ in a groove on the under side of the head, and is primitive for hydrophilid larva.

<sup>2</sup>*Spercheus* larvæ show primitive tendencies but the adult possesses only five abdominal sternites.



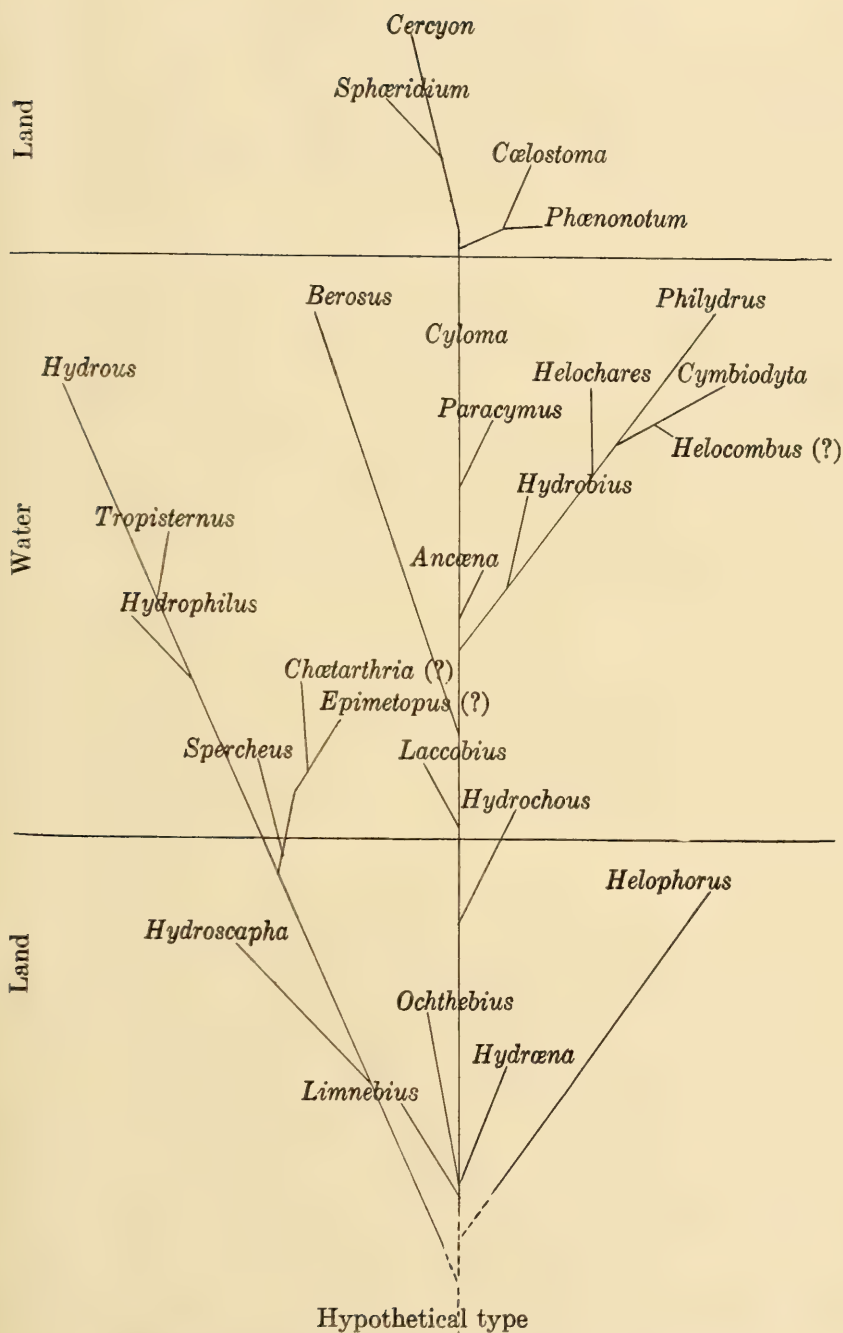
Ganglbauer divided the family into five subfamilies: Helophorinæ; Hydræninæ; Sphercheinæ; Hydrophilinæ; and Sphæridiinæ. It will be seen that four more have been considered here. Recent authors have laid stress upon larval characters in the determination of subfamilies. Limnebiini was raised to subfamily rank by d'Orchymont, 1913, and Hydroscaaphidæ was placed under the Hydrophilidæ, as Hydroscaaphinæ, by Böving, 1916. If the larval characters are to be accepted, surely the Hydrobiini and Hydrochoini are worthy of subfamily rank. The structures which characterize the immature stages of these subfamilies are listed on pages 27 and 42 respectively. The adult characters offer differences as well. The Hydrobiinæ differ strikingly from the Hydrophilinæ in general form, the latter being very much better adapted to water life. The Hydrochoinæ possess only seven-segmented antennæ (the last three segments pubescent) and six abdominal sternites, the second to fifth furrowed and the sixth unchitinized but prominent. The Hydræninæ, with which Ganglbauer linked them, possess eight- to nine-segmented antennæ (the last five segments pubescent) and six or seven smooth, chitinized, abdominal sternites.

An examination of the phylogenetic tree will show three branches near the base. The one to the left shows the trend of the Hydroscaaphinæ, Sphercheinæ and Hydrophilinæ. In these subfamilies, we find the tendency to develop gills at first and then finally lose them. The branch at the right shows the divergence of the Helophorinæ,<sup>1</sup> as represented by *Helophorus*, from the primitive types of the Limnebiinæ<sup>1</sup> and Hydræninæ. Ganglbauer considered Helophorinæ more primitive than those which have been placed nearer the base but the only character which could possibly suggest a more generalized larva is its three-segmented cerci. In its other structures it is very much more specialized.

On the main branch, Limnebiinæ and Hydræninæ are near the base and lead toward the Hydrobiinæ, with the Hydrochoinæ representing the stepping-stone. The latter subfamily clearly bridges the gap between the land forms and the water forms. *Berosus*, in its adaptation to water, is clearly the most advanced of the Hydrobiinæ. The pleural gills are remarkably well developed and only a slight indication of a former stigmatic atrium is discernible.

The branch with *Hydrobius*, *Helocombus* (?), *Cymbiodyta* and *Helochares* shows a tendency to a sublinear form and the gradual reduction of the number of inner teeth on the mandibles. It terminates in *Philydrus*,

<sup>1</sup>The larva of *Helophorus* closely resembles that of *Hister*, while the larvæ of the Limnebiinæ are strikingly similar to those small Staphylinidæ, belonging to the Tachyporini, and to *Choleva*, *Liodes*, and *Agathidium* of the Silphidæ.



PHYLOGENETIC TREE BASED UPON LARVAL CHARACTERS

a genus possessing larval prolegs and manifesting a relationship to the cruciform type of larva.

*Ancæna* and *Paracymus*, with the gradual reduction of legs, lead through *Cyloma*<sup>1</sup> to the *terminus terrestre*, the subfamily Sphæridiinae.

#### IV. KEYS

An attempt is made to separate the genera in their immature stages. Schiödte, 1862, gave excellent keys, written in Latin, for all the stages, but they are necessarily incomplete. The main divisions of his pupal key have been incorporated here. The only contemporary work of note is the larval key given by d'Orchymont, 1913. His grouping of the genera is a very natural one; however, on account of additional material, new keys have been considered advisable. Representatives of all the genera have been examined with the exception of *Cercyon*, the data for which have been taken from literature.

#### KEY FOR THE IDENTIFICATION OF THE EGG-CASES

- |   |   |
|---|---|
| 1. Eggs laid singly.....  | 2.  |
| Eggs laid in a mass.....  | 5.  |
| 2. Covered with silk, either closely or loosely applied.....  | 3.  |
| Entirely naked.....   | <i>Ochthebius</i> (in part); <i>Hydroscapha</i> . |
| 3. Silk loosely applied, eggs visible.....  | <i>Ochthebius</i> (in part); <i>Limnebius</i> .   |
| Silk closely applied, only contour of egg visible.....  | 4.  |
| 4. Eggs not entirely enclosed, with only a blanket-like covering, nearly regular in outline, oval.....          | <i>Hydræna</i> .                                  |
| Egg entirely enclosed, irregular in outline, with little stanchions.....  | <i>Hydrochous</i> .                               |
| 5. Egg-mass covered with closely applied silk, eggs invisible.....  | 6.  |
| Egg-mass covered with silk, eggs visible.....   | 17.   |
| 6. With a prominent projection at the cap end (armed).....  | 7.  |
| Without a prominent projection (unarmed). The projection, if present, is represented only by small strands..... | 14.   |
| 7. Projection ribbon-like.....  | 8.  |
| Projection spine-like.....  | 12.   |
| 8. Projection tubular.....  | 9.  |
| Projection flattened.....   | 11.   |
| 9. Tubular projection opened distally.....  | <i>Helophorus</i> .                               |
| Tubular projection closed distally.....   | 10.   |

<sup>1</sup>The *Cyloma* larva is not known, but the adult, according to Ganglbauer, shows the relationship of the Hydrobiini to the Sphæridiinae.



10. Projection distinctly tubular proximally. Case proper nearly spherical.  
*Laccobius; Ancæna.*  
 Projection not distinctly tubular proximally. Case somewhat chestnut-shaped.  
 Contour of eggs visible at the cap end.....*Berosus.*
11. Filament broader and often surrounding the cap end. Case nearly spherical.  
*Hydrobius.*  
 Filament narrower. Case proper more elongate and smaller.....*Philydrus.*
12. Cases (free floating) noticeably larger. Cap hatchet-shaped and not covering entire end.....13.  
 Cases (attached to aquatic vegetation) smaller. Cap round and covering entire end.....*Tropisternus.*
13. Case naked, spine-like projection stout.....*Hydrous.*  
 Case enwrapped in a leaf, spine-like projection slender and tip often bent over.  
*Hydrophilus.*
14. Eggs laid on damp leaves (blanket-like covering of silk).....*Phænonotum.*  
 Case carried on the under side of the body by the female.....15.
15. Case attached to the hind legs.....16.  
 Case held in place by the elytra and modified abdominal segments.  
*Epimetopus; Chætarthria?*
16. To the femora only.....*Helochares.*  
 To the femora and tibiae.....*Spercheus.*
17. Egg-mass deposited near the water, usually under fallen leaves.....18.  
 Egg-mass deposited in dung or damp earth.....19.
18. Egg-mass usually larger. Number of eggs varies from 15-43.....*Cymbiodyta.*  
 Egg-mass usually smaller. Number of eggs varies from 10-15.....*Paracymus.*
19. Egg-mass larger.....*Sphæridium.*<sup>1</sup>  
 Egg-mass smaller.....*Cercyon* (?).

#### KEY FOR THE IDENTIFICATION OF THE LARVÆ

1. Nine complete abdominal segments, the tenth reduced but distinct. Integument noticeably chitinated.....2.  
 Eight complete abdominal segments, the ninth and tenth reduced and forming a stigmatic atrium (except in *Berosus* in which the atrium has not developed). Integument not noticeably chitinated (except in *Hydrochous*).....6.
2. Head inclined; epicranial suture present; ocular areas in groups of five; mandible with *lacinia mobilis*: maxilla primitive with prominent inner lobe; labium and maxillæ inserted in a furrow on the under side of the head; gula well developed and attaining the occipital opening. Cerci absent or well developed and two-segmented.....3.

<sup>1</sup>No account is given of the eggs of *Sphæridium* or *Cercyon* except the situation in which they are laid. I have observed only a single mass of *Sphæridium* eggs.

Head slightly elevated, nearly horizontal; epicranial suture absent; ocular areas in groups of six; mandibles sharply pointed, with inner teeth; maxilla palpiform; labium and maxilla inserted at the anterior margin of the under side of the head; gula reduced and distant from the occipital opening. Cerci well developed and three-segmented. . . . . *Helophorus*.

3. Antennæ very short; ocular areas aggregated; clypeus lacking or fused with labrum; no well-defined spiracles; tracheal gills on the prothorax, and first and eighth abdominal segments; cerci absent; each abdominal segment with a continuous band of chitin; tenth or anal segment with a ventral sucker and two terminal pencil-shaped appendices. . . . . *Hydrosapha*.

Antennæ rather long; ocular areas distant; clypeus and labrum both distinct; nine pairs of annuliform spiracles; no tracheal gills; cerci two-segmented and well developed; each abdominal segment with a ventral and dorsal plate of chitin; tenth or anal segment without a ventral sucker and with two small terminal hooks. . . . . 4.

4. Antennæ usually shorter, with no prominent inner swellings; setæ on the clypeus not placed at the anterior margin and the two median ones distant from each other; *lacinia mobilis* narrower; inner lobe of maxillæ not distinctly divided apically; cerci nearly contiguous proximally and divergent. . . . *Ochthebius*.

Antennæ usually longer, with prominent inner swellings; setæ on the clypeus placed at the anterior margin and equidistant; *lacinia mobilis* broader; inner lobe of maxillæ distinctly divided apically; cerci widely separated proximally and nearly parallel. . . . . 5.

5. Third segment of antennæ without inner swellings, second segment with a single antennal appendage; a pair of pectinate setæ at the anterior margin of the labrum; inner lobe of maxillæ slightly divided apically; labium broadened distally. . . . . *Hydræna*.

Third segment of antennæ with an inner swelling; second segment with two slender antennal appendages; no pectinate setæ at the anterior margin of the labrum; inner lobe of maxillæ strongly divided; labium not noticeably broadened distally, although sides of mentum are rounded. . . . *Limnebius*.

6. Head slightly inclined or horizontal; antennæ with their points of insertion nearer the externo-frontal angles than those of the mandibles; ocular areas in groups of five or six; labium and maxillæ inserted in a furrow on the under side of the head; gula well developed and attaining the occipital opening. . . . . 7.

Head elevated; antennæ with their points of insertion farther from the externo-frontal angles than those of the mandibles; ocular areas in groups of six; labium and maxillæ inserted at the anterior margin of the under side of the head; gula reduced and not attaining the occipital opening. . . . . 8.

7. Ocular areas in groups of five, not aggregated; epicranial suture very short, nearly absent; mandibles sharply pointed and with inner teeth; palpifer with an inner claw-like lobe; abdominal segments without chitinous plates.

*Spercheus*.

- Ocular areas in groups of six, aggregated; epicranial suture entirely absent, each mandible with a terminal seta, inner tooth and *lacinia mobilis*; palpifer with the inner rudimentary lobe not claw-like; abdominal segments with well-developed chitinous plates.....*Hydrochous*.
8. Type pseudo-apneustic. Seven pairs of very prominent tracheal gills present on the abdomen. Ninth and tenth abdominal segments very much reduced and no stigmatic atrium present.....*Berosus*.  
Type pseudo-metapneustic. Tracheal gills not nearly as prominent or absent. Ninth and tenth abdominal segments reduced, forming a stigmatic atrium...9.
9. Ocular areas round, usually small and more closely aggregated; legs reduced or absent; pleural lobes not prominent; abdomen truncate.....19.  
Ocular areas oval, larger, aggregated but more distant; legs well developed, visible from above except in *Paracymus*; pleural lobes usually prominent; abdomen not noticeably truncate, more or less elongate.....10.
10. First segment of antennæ not distinctly longer than the following two taken together; finger-like antennal appendage present; labro-clypeus with teeth usually well defined; mouth-parts stouter; mandibles not grooved internally; stipes large and swollen, usually with an inner row of five stout setæ; externo-frontal angles of mentum not prominent, rounded; legs much shorter, femora without fringes of swimming hairs; gills and prostyles absent.....11.  
First segment of antennæ distinctly longer than the following two taken together; finger-like antennal appendage absent; labro-clypeus with teeth small or absent; mouth-parts more slender; mandibles grooved internally; stipes not swollen, with setæ arranged differently; externo-frontal angles of mentum prominent and acute; legs very long; femora with fringes of long swimming hairs; gills present (*Hydrophilus*, *Tropisternus*) or absent (*Hydrous*); prostyles present.....17.
11. Frontal sutures parallel and not uniting to form an epicranial suture; left expansion of epistoma much more prominent than the right and with a row of stout setæ; ligula absent; reduced sclerites of meso- and metathorax widely separated; tarsus well developed, about as long as tibia.....*Laccobius*.  
Frontal sutures not parallel and may or may not unite to form an epicranial suture; lateral expansions of epistoma similar and usually in line with the anterior margin of the labro-clypeus, no rows of stout setæ except in *Hydrobius*; ligula present and longer than the first segment of the palpus; sclerites of meso- and metathorax reduced but not so widely separated; tarsus less developed usually much shorter than the tibia.....12.
12. Antennæ shorter and antennal appendage more prominent, especially in the first stage larva; epicranial suture absent; legs reduced; abdomen more truncate; cercus with long terminal seta.....13.  
Antennæ longer and antennal appendage less prominent; epicranial suture present but usually short; legs fairly long, not reduced; abdomen narrowed caudally; cercus with a shorter terminal seta.....14.



13. Frons truncate behind; labrum tridentate, the lateral teeth bifid; mandibles symmetrical, each with two inner teeth; palpiger enlarged in front; ligula about as long as palpi, apparently two-segmented; anterior margin of pronotum without a fringe of stout setæ; legs not visible from above. . . . *Paracymus*.  
Frons rounded behind; labrum quadridentate; mandibles symmetrical, each with three inner teeth; palpiger not enlarged in front; ligula not as long as the palpi, one-segmented; anterior margin of pronotum with a fringe of stout setæ; legs barely visible from above. . . . . *Ancæna*.<sup>1</sup>
14. Mandibles symmetrical, each with two or three inner teeth; abdomen without prolegs. . . . . 15.  
Mandibles asymmetrical, the right with two inner teeth, the left with only one; abdomen with prolegs on the third to seventh segments. . . . *Philydrus*.
15. Labro-clypeus with five distinct teeth, the outer left tooth a little distant from the rest; each mandible with three inner teeth; mentum subquadrangular. . . . . *Hydrobius*.  
Labro-clypeus with at least six teeth; each mandible with two inner teeth; mentum cordiform. . . . . 16.
16. Labro-clypeus with six distinct teeth, placed in two groups, two on the left and four on the right, mentum covered with small spines; anterior sclerites of the metathorax with caudal projections. . . . . *Helochares*.  
Labro-clypeus with more than six teeth, those towards the right not clearly defined and with several smaller teeth; mentum with small spines only towards the base; anterior sclerites of the metathorax without caudal projections, rectangular. . . . . *Cymbiodyta*.
17. Head subspherical; labro-clypeus without teeth; each mandible with a single inner tooth; ligula not longer than first palpal segment; gills absent; pronotum not entirely chitinized. . . . . *Hydrous*.  
Head subquadrangular, narrowed behind; labro-clypeus with inconspicuous teeth; each mandible with more than one, usually with two inner teeth; ligula distinctly longer than first palpal segment; pronotum entirely chitinized, gills present but more or less rudimentary. . . . . 18.
18. Mentum transverse; sides only slightly rounded; fronto-external angles very prominent; pleural gills rudimentary but indicated by tubercular projections, each with several terminal setæ. . . . . *Tropisternus*.  
Mentum, convex, with its sides strongly rounded towards its basal half, its sides serrate in the last instar; fronto-external angles less prominent; pleural gills fairly well developed and pubescent. . . . . *Hydrophilus*.<sup>2</sup>
19. Head ovate or subspherical; antennal appendage shorter; mandibles asymmetrical; stipes broadened and depressed on its outer side; ligula<sup>3</sup> exceeding the palpi and pointed; median line on ventral side of the head impressed and with a small pit mid-way; legs incomplete; abdomen without ventral suckers. . . . . 20.

<sup>1</sup>The characters found in *Ancæna infusca* are incorporated here. It seems possible that *Ancæna limbata*, the larva of which d'Orchymont, 1913, described, may really belong to the genus *Paracymus*, as its characters more closely resemble the latter genus.

<sup>2</sup>D'Orchymont says in his key that the tarsus of *Hydrophilus* is toothed on the inner side, but only the two inner setæ are found in *H. obtusatus*.

<sup>3</sup>The specimens at hand do not show the ligula formed as described here, but more larvæ will have to be examined before Schiödte's figure is discredited.

- Head quadrangular; antennal appendage about the length of the third segment; mandibles symmetrical, each with two inner teeth; stipes swollen, not broadened or depressed externally; ligula about as long as the first palpal segment and not pointed; median line not impressed and pit absent; legs reduced but complete; each abdominal segment with a ventral sucker.....21.
20. Head subspherical; ocular ares aggregated but more distant from each other; mandibles without inner teeth, furrowed on the inner side; mentum cordiform; tarsi absent; procercus and appendage of seventh intersegmental membrane fleshy and long.....*Sphæridium*.  
Head ovate; ocular areas closely aggregated and sometimes appearing as one; right mandible with a single inner tooth; mentum short, transverse; legs absent; procercus and appendage of the seventh intersegmental membrane reduced and barely indicated.....*Cercyon*.
21. Clypeus tridentate.....*Phænonomotum*.  
Clypeus unidentate.....*Cælostoma*.

#### KEY FOR THE IDENTIFICATION OF THE PUPÆ

1. Metathoracic wing-cases visible from above.....2.  
Metathoracic wing-cases not visible.....9.
2. Motary styli of abdominal tergites in transverse rows of six each; abdominal tergites with small lateral tubercles; spiracles not hidden; abdominal pleurites confused with the tergites.....7.  
Motary styli of abdominal tergites in transverse rows of four each; abdominal tergites with large lateral tubercles; spiracles not hidden but partly concealed by the lateral tubercles of the tergites; abdominal pleurites well defined...3.
3. Supraorbital styli less than two in number; metasternal spine and inner spur of metatibia prominent; eighth abdominal tergite with two small, rounded tubercles, each bearing a terminal stylus at the posterior margin.....6.  
Supraorbital styli two in number; no metasternal spine; inner spur of metatibia not prominent; eighth abdominal tergite without tubercles as above...4.
4. Pronotal styli 16 in number, all situated near the margins; cerci short.  
*Helophorus*.  
Pronotal styli 24-26 in number, all of them not situated near the margins; cerci long.....5.
5. Pronotal styli 26 in number, long and slender; abdominal styli varying in size, the lateral tergal styli very long and slender, the pleural styli very short and conical; eighth abdominal tergite without appendages resembling cerci; externo-caudal angles of ninth segment not acute; cerci long, very crooked and multiannulate distally.....*Berosus*.  
Pronotal styli 24 in number; abdominal styli subequal; eighth abdominal tergite with a pair of appendages resembling cerci; externo-caudal angles of ninth segment prominent and acute; cerci long, only slightly crooked and apparently not annulate.....*Laccobius*.

6. Larger in size, more than 25 mm. long; one supraorbital stylus; only 16 well-developed pronotal styli but several other inconspicuous ones; cerci<sup>1</sup> nearly 3.5 mm. long, superficially annulate, and not bifid (?).....*Hydrous*.  
Smaller in size, less than 12 mm. long; no supraorbital styli; 22 well-developed pronotal styli; cerci about 1.45 mm. long, superficially annulate, slightly bifid and acute.....*Tropisternus*.
7. Larger in size, more than 13 mm. long; pronotal styli numerous, 32 in number; eighth abdominal tergite with two, small, rounded tubercles, each bearing a short terminal stylus; cerci slightly bifid and acuminate.....*Hydrophilus*.  
Smaller in size, less than 8 mm. long; pronotal styli fewer, 24 in number; eighth abdominal tergite without the tubercles mentioned above but with a pair of styli; cerci not bifid, acuminate or thread-like distally.....8.
8. Smaller in size, less than 3 mm.; styli are short with long terminal setæ; the styli at the anterior margin of the pronotum 10 in number, four in the middle and three towards each side.....*Paracymus*.  
Larger in size, more than 3 mm.; styli not noticeably short nor the terminal seta long, about equal to each other; the styli at the anterior margin of the pronotum 6 in number, two in the middle and two towards each side; the two end styli on each side, which were present in the above, have moved to a distinct lateral position.....*Cymbiodyta*; *Philydrus*; *Helochares*.<sup>2</sup>
9. Abdominal pleurites often confused with the tergites; cerci long, slender, acuminate, multiannulate.....*Cercyon*.  
Abdominal pleurites distinct; cerci short, conical, two-segmented...*Sphæridium*.

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<sup>1</sup>The cerci are broken off in the specimen at hand. They are probably not bifid, as Matheson, 1914, does not mention it in *H. triangularis*.

<sup>2</sup>There appear to be no distinct characters for the separation of these three genera. The arrangement of the pronotal setæ differ slightly but cannot be incorporated into the key. Examination of the metathoracic tarsus shows, however, the four-segmented condition in *Cymbiodyta* and the five-segmented in *Philydrus* and *Helochares*.



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## PLATE I

- Fig. 1. Labium, ventral view. *Hydrophilus obtusatus* larva.  
 Fig. 2. Head without appendages, dorsal view.  
 Fig. 3. Egg-case. *Hydrobius fuscipes*.  
 Fig. 4. Mandible of primitive larva of *Ochthebius* type.  
 Fig. 5. Maxilla of specialized type of Hydrophilid larva.  
 Fig. 6. Caudal view of open stigmatic atrium. *Hydrophilus obtusatus*.  
 Fig. 7. Side view of last three segment of larva. *Hydrous triangularis*.  
 Fig. 8. Side view of caudal end of larva with anus protruded. *Hydrobius fuscipes*.  
 Fig. 9. Dorsal view of closed stigmatic atrium of larva. *Philydrus nebulosus*.  
 Explanation of Lettering on Plate I. \* Numbers Refer to the Abdominal Segments.

*a*, anus; *ab*, abductor muscle; *ac*, acrocercus; *ad*, adductor muscle; *ai*, antennal insertion; *ap*, anterior piece of mandible; *c*, condyle; *ca*, cardo; *cp*, cap of egg-case; *e*, lateral expansion of epistoma; *ep*, egg-case proper; *es*, epicranial suture; *f*, frons; *fa.s*, frontal antennal suture; *fe.s*, fronto-epistomal suture; *fl*, filament of egg-case; *g*, gula; *l*, ligula; *lb.pl*, labial palpus; *l.cl*, labro-clypeus; *ll*, lateral lobe; *lm*, lacinia mobilis; *m*, mentum; *ma*, molar area; *mc*, mesocercus (true cercus); *ml*, median lobe; *mx.pl*, maxillary palpus; *oa*, ocular area; *oc*, occipital opening; *pc*, procercus or process of eighth pleurite; *plf*, palpifer; *plf.l*, lobe of palpifer; *plg*, palpiger; *pp*, posterior piece of mandible; *sc*, sense-cones; *sm*, submentum; *st*, stipes; *t*, trochantin; *tr*, trachea.



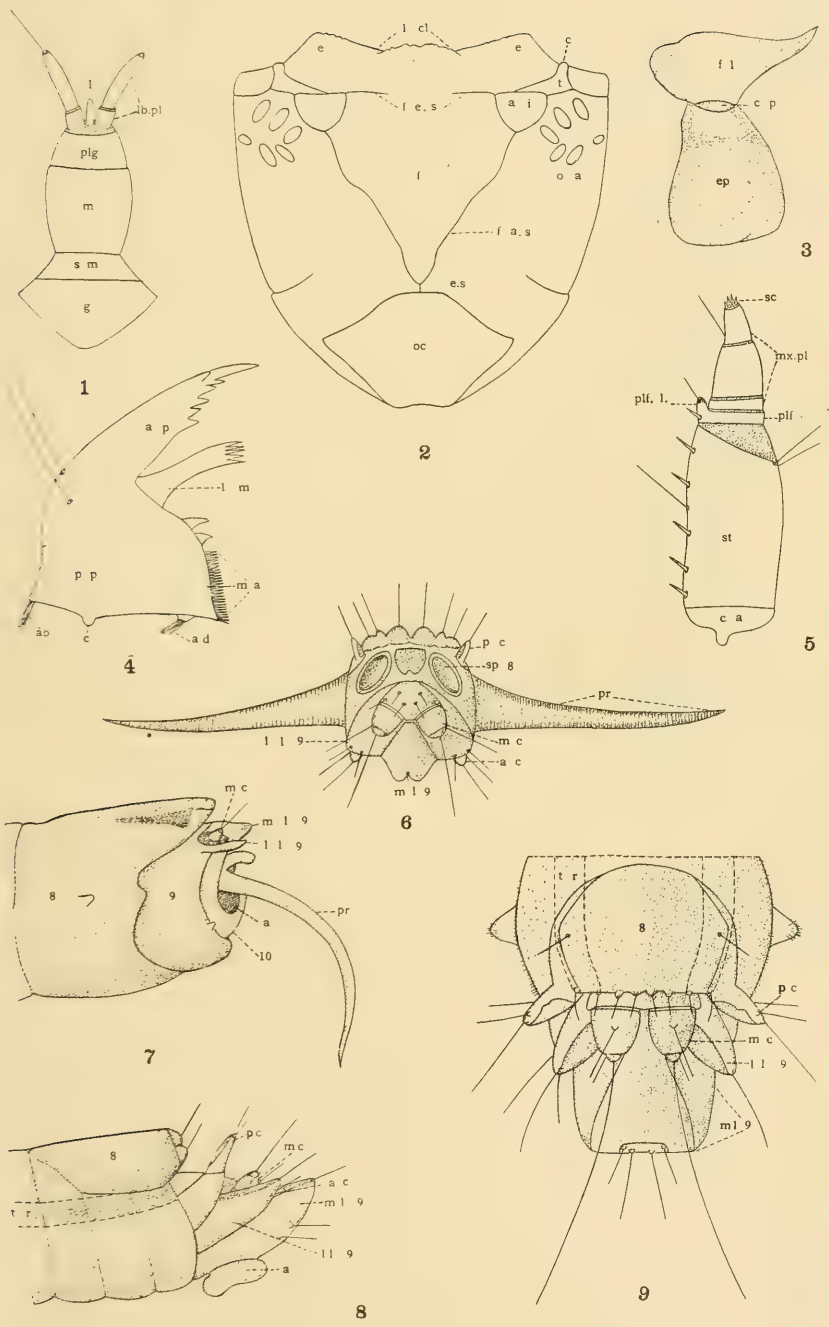


PLATE II

*Helophorus lacustris* LeConte

- Fig. 1. Left mandible, first stage larva.
- Fig. 2. Right antenna, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Right maxilla, first stage larva.
- Fig. 5. Head, dorsal view of the anterior part, first stage larva.
- Fig. 6. Right mesothoracic leg, first stage larva.
- Fig. 7. Larva, dorsal view, first stage.
- Fig. 9. Labium, dorsal view, first stage larva.
- Fig. 10. Egg-case.

*Helophorus* sp. ?

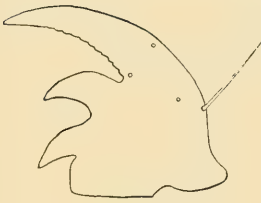
- Fig. 8. Egg-case.



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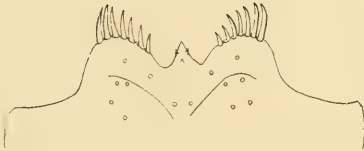
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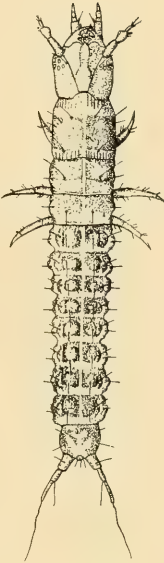
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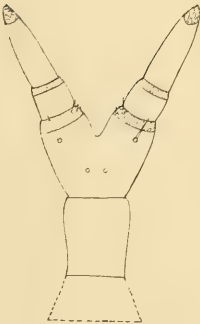
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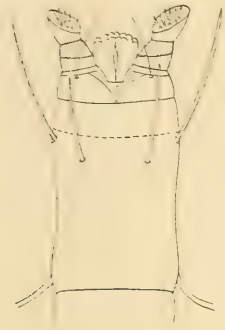
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PLATE III

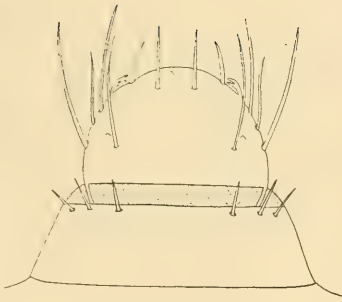
*Ochthebius tuberculatus* LeConte

- Fig. 1. Labium, ventral view, first stage larva.
- Fig. 2. Labrum and clypeus, dorsal view, first stage larva.
- Fig. 3. Labium, dorsal view, first stage larva.
- Fig. 4. Tip of right mandible, ventral view, first stage larva.
- Fig. 5. Tip of left mandible, ventral view, first stage larva.
- Fig. 6. Right maxilla, first stage larva
- Fig. 7. Right mesothoracic leg, first stage larva.
- Fig. 8. Right mandible, first stage larva.
- Fig. 9. Caudal end of the anal segment, side view, first stage larva.
- Fig. 10. Egg with loose covering of silk.
- Fig. 11. Right antenna, first stage larva.
- Fig. 12. Larva, dorsal view, first stage.

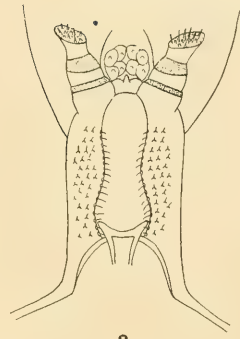




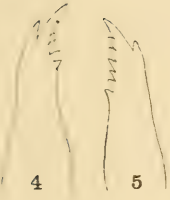
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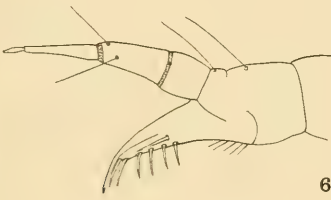
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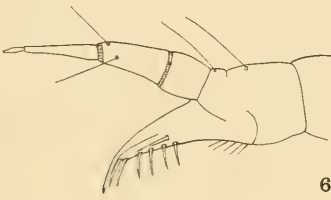
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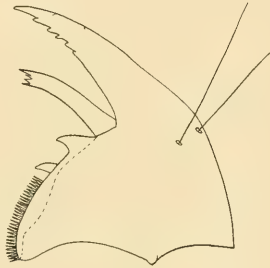
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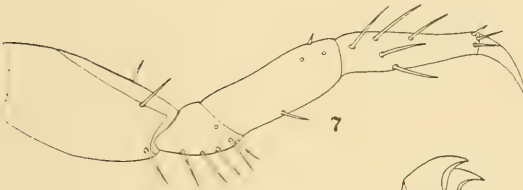
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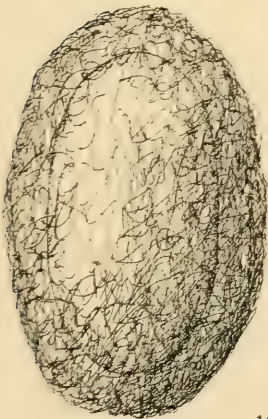
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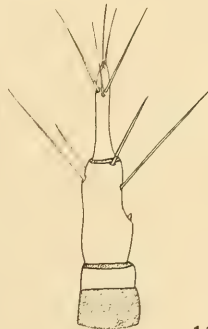
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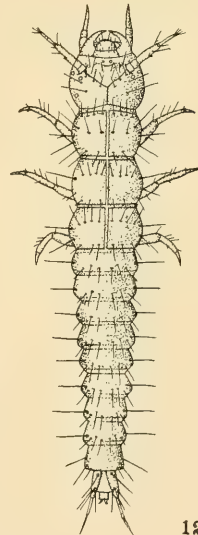
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PLATE IV

*Hydræna pennsylvanica* Kiesenwetter

- Fig. 1. Labium, ventral view, first stage larva.
- Fig. 2. Right antenna, first stage larva.
- Fig. 3. Labium, dorsal view, first stage larva.
- Fig. 4. Labrum and clypeus, dorsal view, first stage larva.
- Fig. 5. Tip of right mandible, ventral view, first stage larva.
- Fig. 6. Tip of left mandible, ventral view, first stage larva.
- Fig. 7. Right mesothoracic leg, first stage larva.
- Fig. 8. Right mandible, first stage larva.
- Fig. 9. Egg-case, showing the single egg within.
- Fig. 10. Right maxilla, first stage larva.
- Fig. 11. First stage larva, dorsal view.

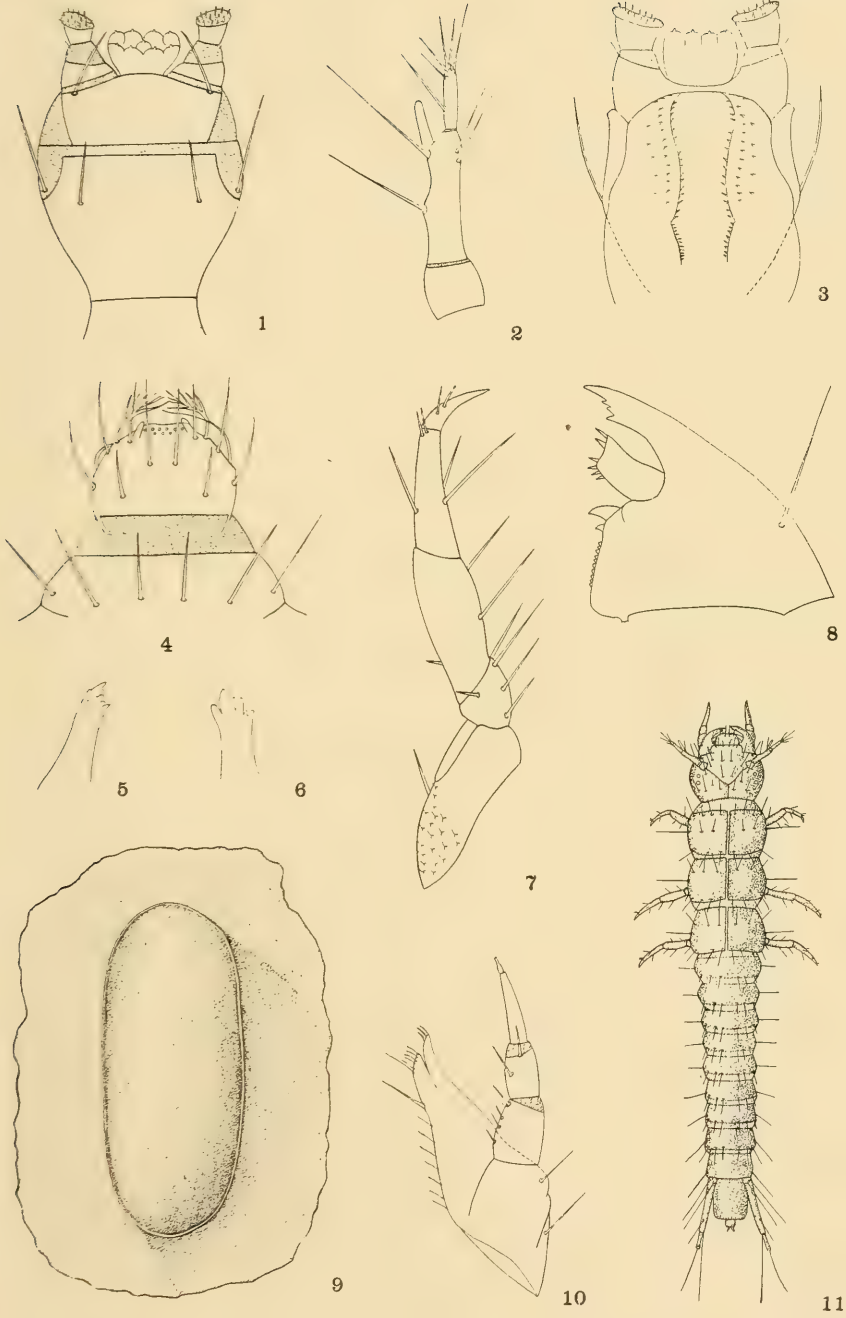
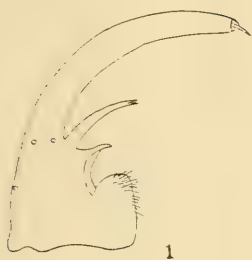


PLATE V

*Hydrochous squamifer* LeConte

- Fig. 1. Left mandible, first stage larva.
- Fig. 2. Ventral side of head with mouth-parts removed except labium. First stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Right maxilla, first stage larva.
- Fig. 5. Anterior region of head, dorsal view, first stage larva.
- Fig. 6. Right antenna, first stage larva.
- Fig. 7. First stage larva, dorsal view.
- Fig. 8. Right mesothoracic leg, first stage larva.
- Fig. 9. Egg-case, enclosing the single egg.

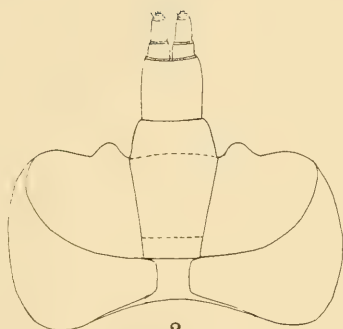




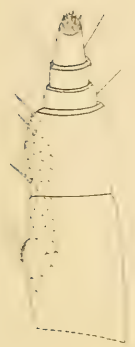
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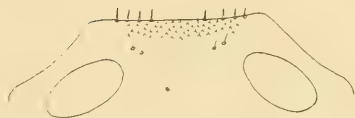
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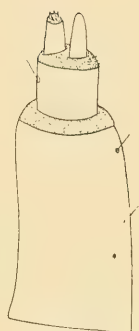
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PLATE VI

*Hydrophilus obtusatus* Say

- Fig. 1. Right mesothoracic leg, first stage larva.
- Fig. 2. Left mandible, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Egg-case with leaf wrapped\* about it.
- Fig. 5. Right maxilla, first stage larva.
- Fig. 6. Labium, dorsal view, first stage larva.
- Fig. 7. Anterior region of head, dorsal view, first stage larva.
- Fig. 8. Full-grown larva, dorsal view.
- Fig. 9. Right antenna, first stage larva.
- Fig. 10. Egg case enlarged and without leaf.

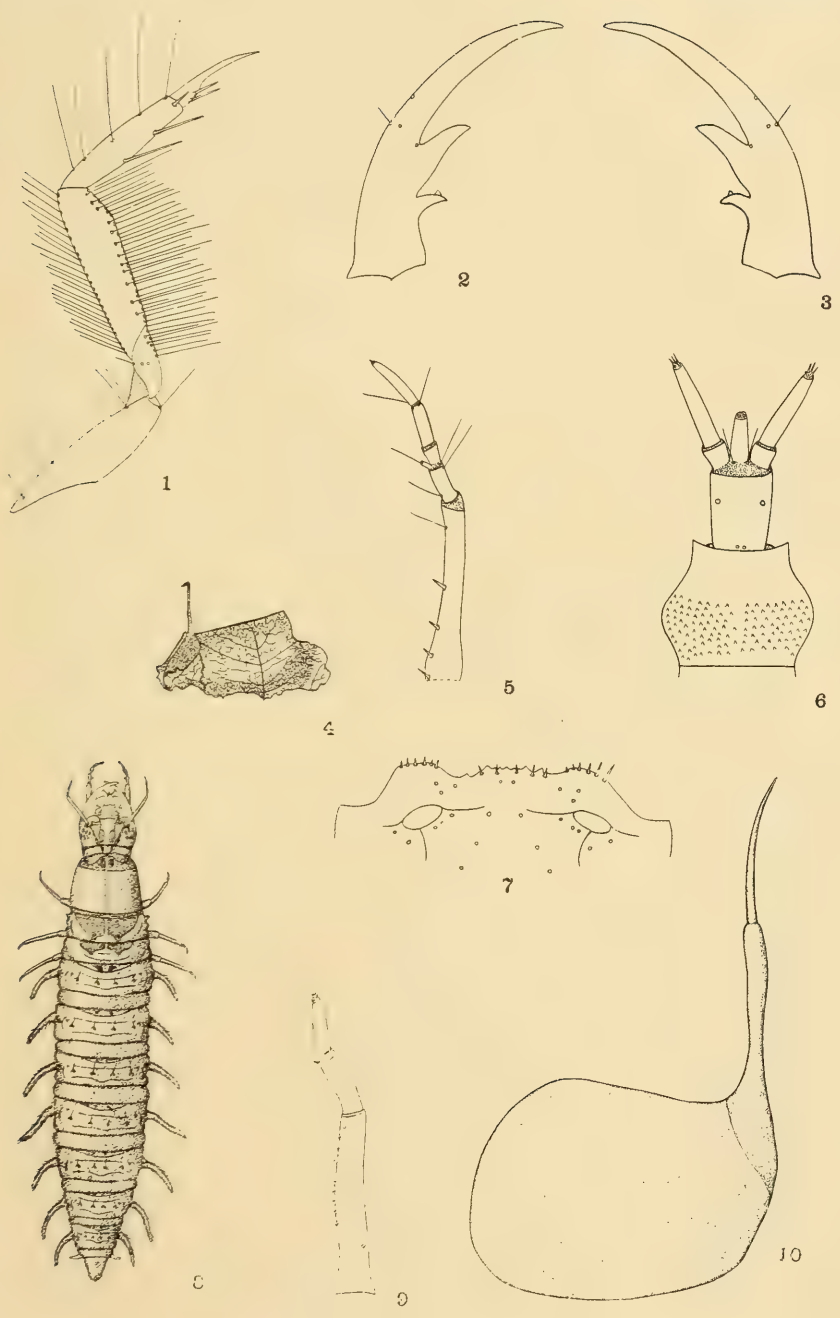


PLATE VII

*Tropisternus glaber* Herbst

- Fig. 1. Left mandible, first stage larva.
- Fig. 2. Right mandible, first stage larva.
- Fig. 3. Right maxilla, first stage larva.
- Fig. 4. Right mesothoracic leg, first stage larva.
- Fig. 5. Right antenna, first stage larva.
- Fig. 6. Anterior region of head, first stage larva.
- Fig. 7. Egg-case, side view.
- Fig. 8. Labium, dorsal view, first stage larva.
- Fig. 9. Full-grown larva, dorsal view.





PLATE VIII

*Hydrous triangularis* Say

- Fig. 1. Full-grown larva, dorsal view.
- Fig. 2. Left mandible, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Right maxilla, first stage larva.
- Fig. 5. Right mesothoracic leg, first stage larva.
- Fig. 6. Right antenna, first stage larva.
- Fig. 7. Head without appendages, dorsal view, first stage larva.
- Fig. 8. Motory stylus of pupa.
- Fig. 9. Egg-case.
- Fig. 10. Labium, dorsal view, first stage larva.

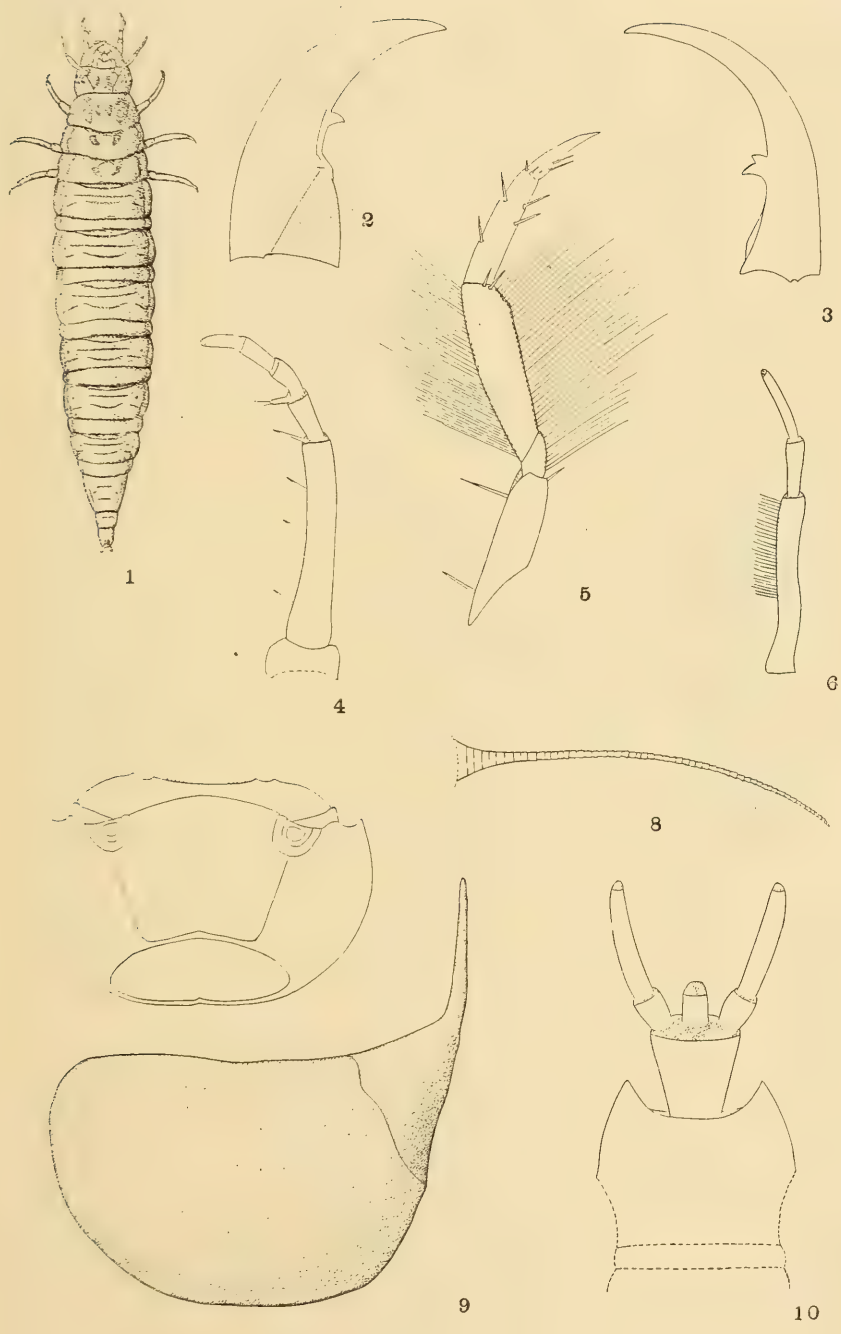


PLATE IX

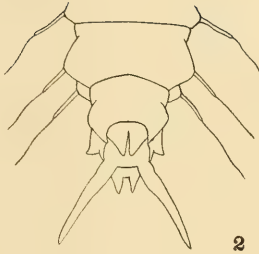
*Laccobius agilis* Randall

- Fig. 1. Left mandible, first stage larva.
- Fig. 2. Extremity of pupa, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Right antenna, first stage larva.
- Fig. 5. Right mesothoracic leg, first stage larva.
- Fig. 6. Full-grown larva.
- Fig. 7. Right maxilla, first stage larva.
- Fig. 8. Anterior region of the head from above, first stage larva.
- Fig. 9. Egg-case. Brown variety.
- Fig. 10. Labium, dorsal view, first stage larva.
- Fig. 11. Egg-case, showing exit hole of larvæ. Silver or light gray variety.





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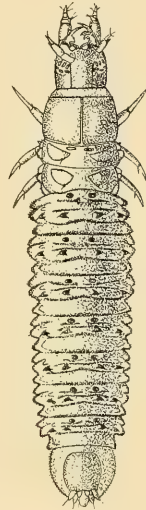
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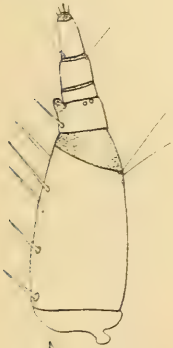
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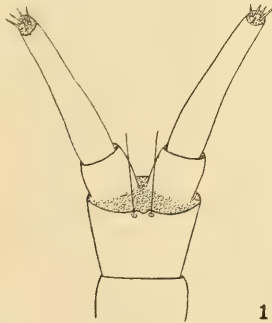
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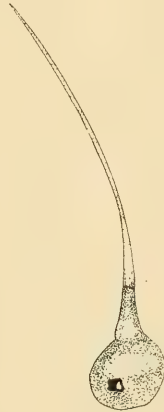
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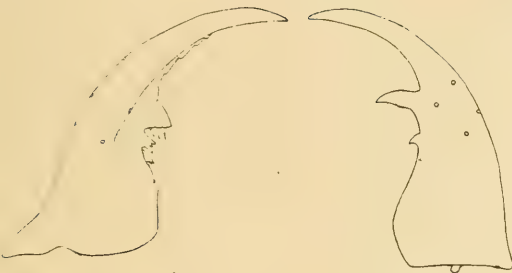


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PLATE X

*Berosus peregrinus* Herbst

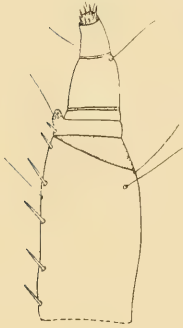
- Fig. 1. Left mandible, first stage larva.
- Fig. 2. Right mandible, first stage larva.
- Fig. 3. Right maxilla, first stage larva.
- Fig. 4. Right mesothoracic leg, first stage larva.
- Fig. 5. Pleural lobe of thorax, first stage larva.
- Fig. 6. Right antenna, first stage larva.
- Fig. 7. Anterior part of head, dorsal view, first stage larva.
- Fig. 8. Full-grown larva, dorsal view.
- Fig. 9. Labium, dorsal view, first stage larva.
- Fig. 10. Egg-case, side view.
- Fig. 11. Egg-case, front view.



1



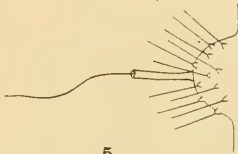
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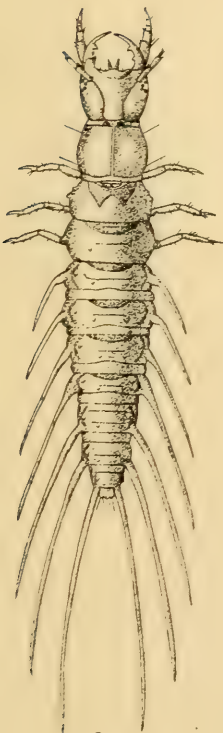
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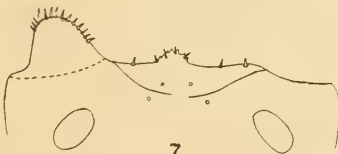
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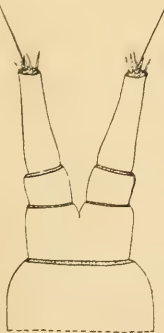
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PLATE XI

*Hydrobius globosus* Say

- Fig. 1. Left mandible, first stage larva.
- Fig. 2. Labium, dorsal view, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Right mesothoracic leg, first stage larva.
- Fig. 5. Right maxilla, first stage larva.
- Fig. 6. Anterior region of head, dorsal view, first stage larva.
- Fig. 7. Right antenna, first stage larva.
- Fig. 8. Egg-case.
- Fig. 9. Full-grown larva, dorsal view.



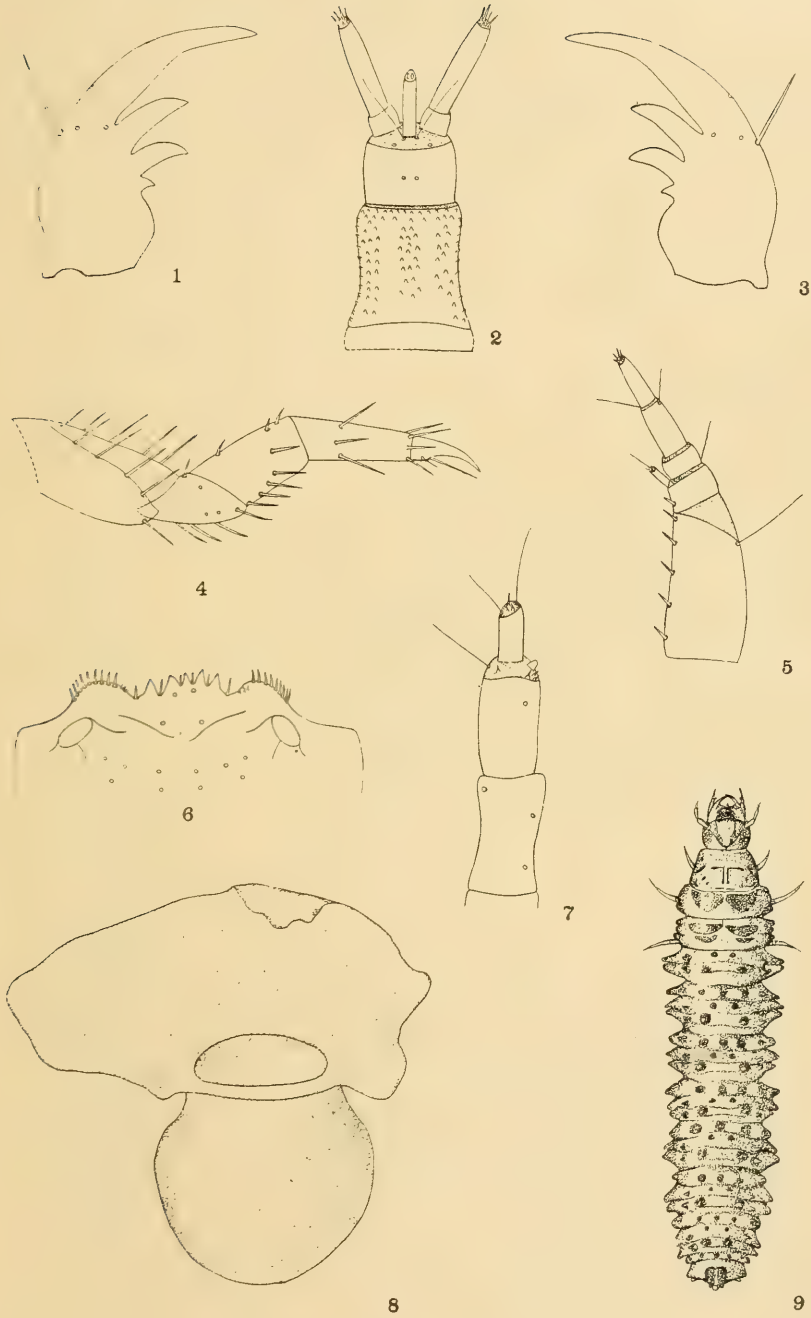


PLATE XII

*Cymbiodyta fimbriata* Melsheimer

- Fig. 1. Left mandible, first stage larva.
- Fig. 2. Labium, dorsal view, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Anterior region of head, dorsal view, first stage larva.
- Fig. 5. Right antenna, first stage larva.
- Fig. 6. Right mesothoracic leg, first stage larva.
- Fig. 7. Full-grown larva, dorsal view.
- Fig. 8. Pupa, ventral view of caudal end.
- Fig. 9. Right maxilla, first stage larva.

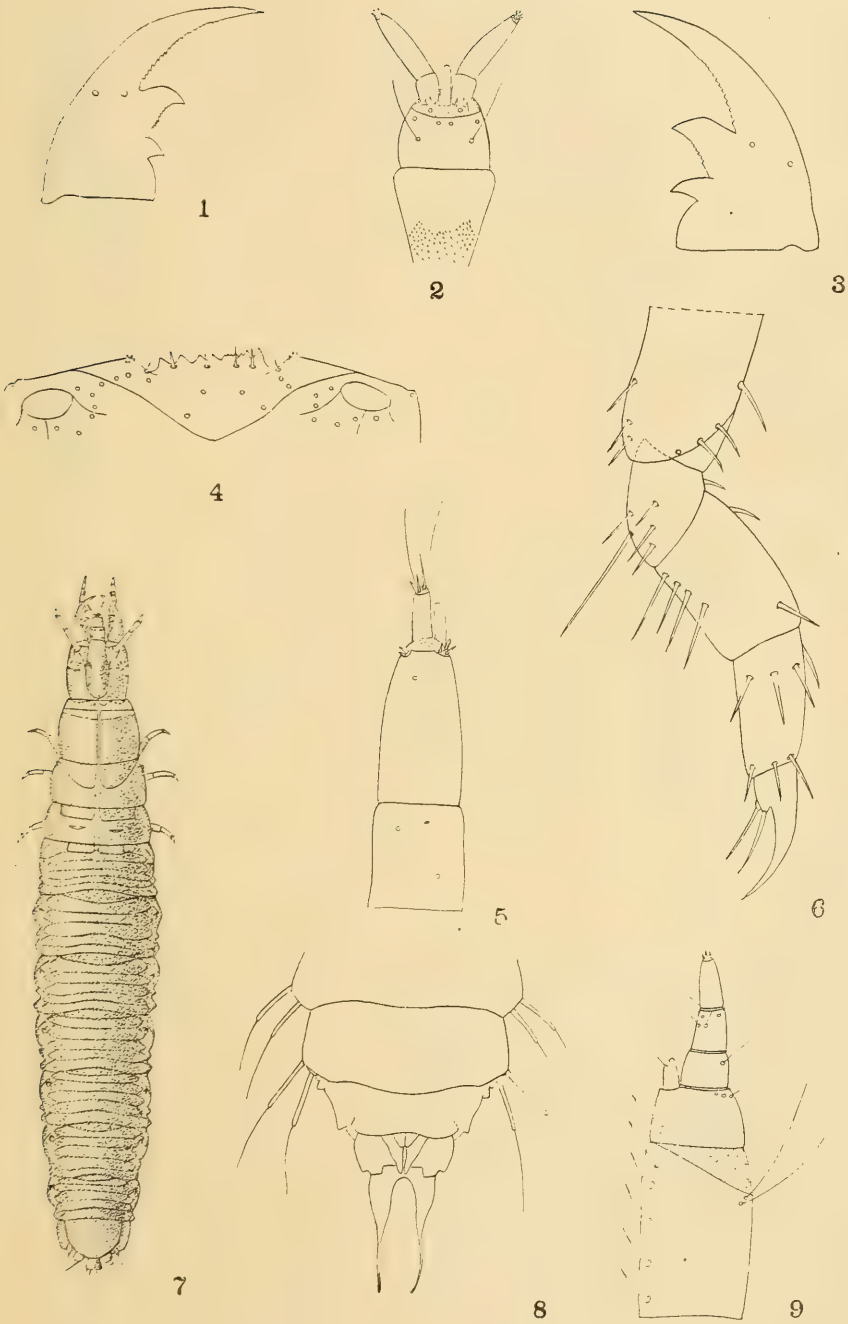


PLATE XIII

*Helochaeres maculicollis* Mulsant

- Fig. 1. Full-grown larva, dorsal view.
- Fig. 2. Left mandible, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Right antenna, first stage larva.
- Fig. 5. Anterior region of head, dorsal view, first stage larva.
- Fig. 6. Right mesothoracic leg, first stage larva.
- Fig. 7. Right maxilla, first stage larva.
- Fig. 8. Labium, dorsal view, first stage larva.
- Fig. 9. Egg-case, ventral view.



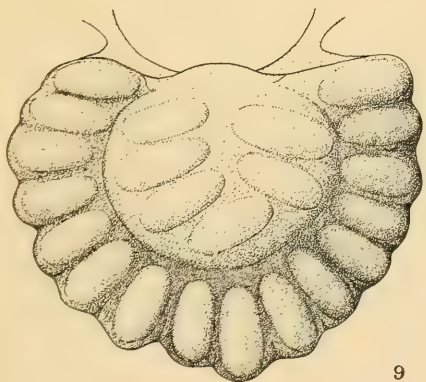
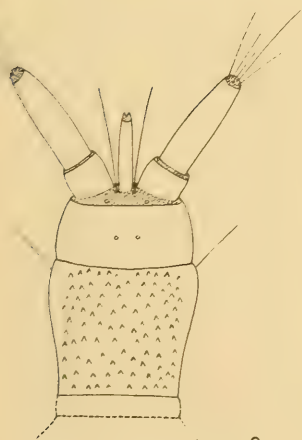
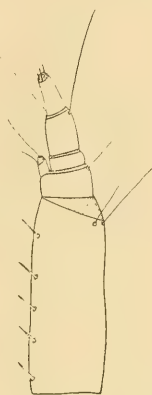
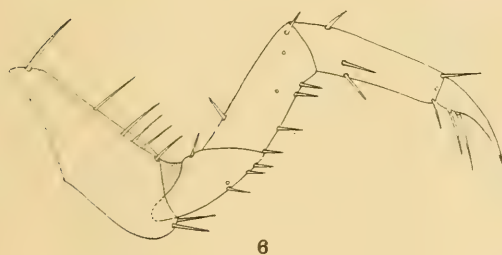
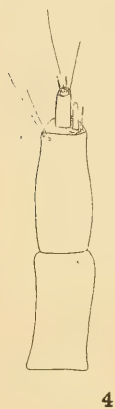
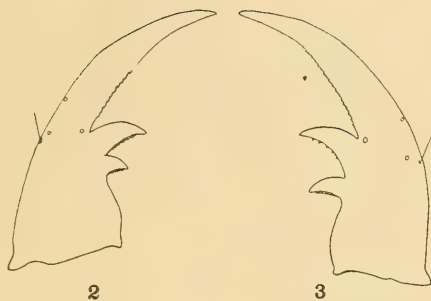
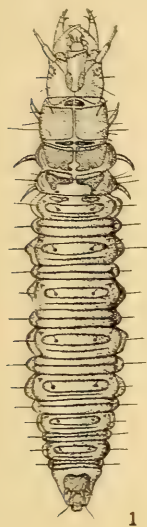


PLATE XIV

*Philydrus perplexus* LeConte

- Fig. 1. Left mandible, first stage larva.
- Fig. 2. Labium, dorsal view, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Labium, ventral view, first stage larva.
- Fig. 5. Right mesothoracic leg, first stage larva.
- Fig. 6. Right maxilla, first stage larva.
- Fig. 7. Right antenna, first stage larva.
- Fig. 8. Anterior region of head, dorsal view, first stage larva.
- Fig. 9. Full-grown larva, dorsal view.
- Fig. 10. Egg-case.

*Philydrus ochraceus*

- Fig. 11. Egg-case.

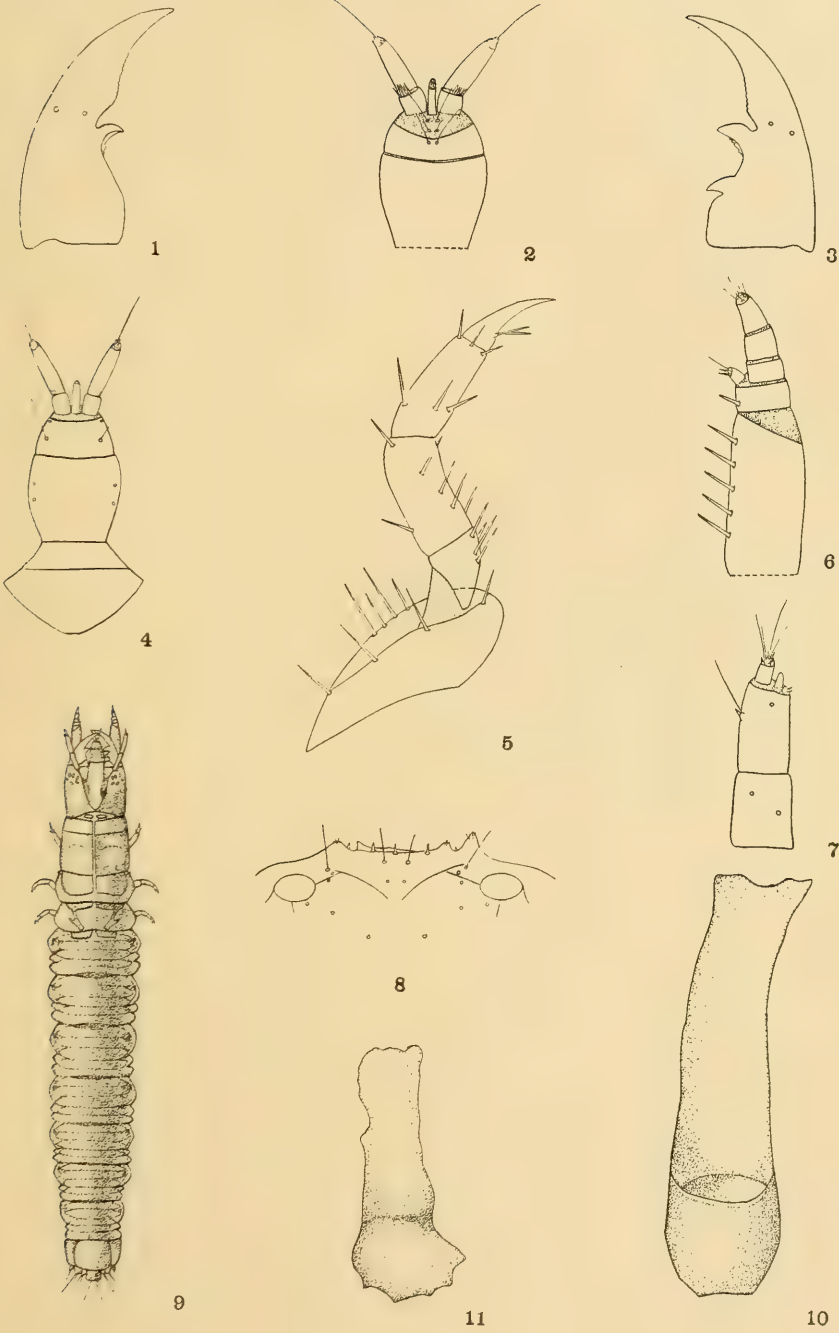


PLATE XV

*Ancæna infuscata* Motschulsky

- Fig. 1. Left mandible of first stage larva.
- Fig. 2. Labium, dorsal view, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Right mesothoracic leg, first stage larva.
- Fig. 5. Right maxilla, first stage larva.
- Fig. 6. Anterior margin of head, dorsal view, first stage larva.
- Fig. 7. Full-grown larva, dorsal view.
- Fig. 8. Right antenna, first stage larva.
- Fig. 9. Egg-case.



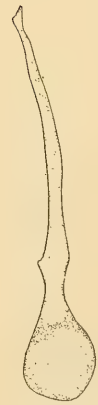
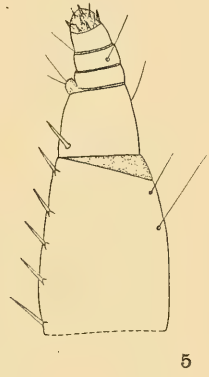
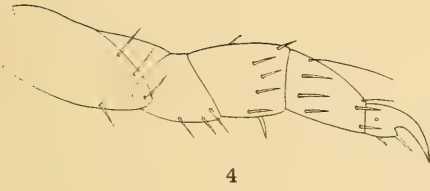
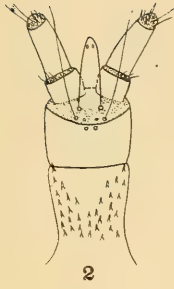
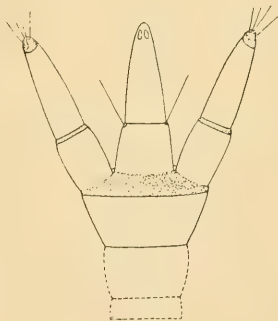
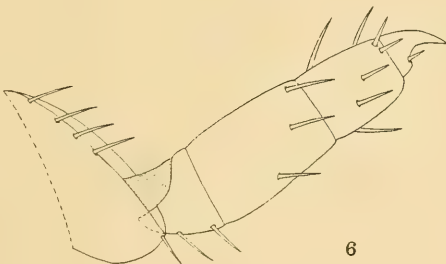
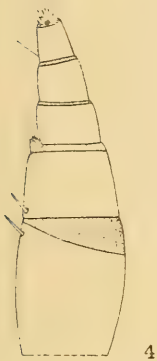


PLATE XVI

*Paracymus subcupreus* Say

- Fig. 1. Left mandible, first stage larva.
- Fig. 2. Right antenna, first stage larva.
- Fig. 3. Right mandible, first stage larva.
- Fig. 4. Right maxilla, first stage larva.
- Fig. 5. Anterior region of head, dorsal view, first stage larva.
- Fig. 6. Right mesothoracic leg, first stage larva.
- Fig. 7. Full-grown larva, dorsal view.
- Fig. 8. Labium, dorsal view, first stage larva.













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